FOR USE IN EXPERIMENTAL SCHOOLS ONLY

BIOLOGY

(PART II)

TEACHING MATERIALS
for
CLASS VII
(EXPERIMENTAL EDITION)

DEPARTMENT OF SCIENCE EDUCATION
NATIONAL COUNCIL OF EDUCATIONAL
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- *a*) The pair of nerves.
- *b*) The thickened part of nerve cord.
- *c*) A net-work of minute nerves.
- *d*) The blood vessels that are found over the brain.

Which of the above statements is correct ?

6. The part of the food canal of earthworm that helps in grinding the soil into pulp is :
   - *a*) Gizzard
   - *b*) Crop
   - *c*) Oesophagus
   - *d*) Intestine

Which of the above statements is correct ?

With Compliments From
PROF. S. K. MITRA,
Ex-Director, NCERT

CHAPTER VI

Molluscs

Have you ever taken a walk along a sea shore ? If you have done so, you might have wondered at the large number of shells on the beach. What are these shells ? Where did they come from? These shells were the parts of certain animals that lived in the sea. After the animals died the shells were washed ashore. Have you observed different kinds of these shells ? They all belong to a large number of different kinds of these animals. These animals having shells possess certain common features. Therefore, all these animals are said to belong to a group This group of animals is **Mollusca.** These animals are without backbones. They have very soft bodies. In order to protect their delicate bodies they have an outer covering of shells. You need not always go to the sea to see these animals. Some animals of this kind are found on land in damp places, gardens, and in water of rivers, reservoirs, ponds, etc.

§ 1. SNAILS

Visit a nearby pond and collect some animals bearing twisted shells on their bodies. These animals are snails. You wi

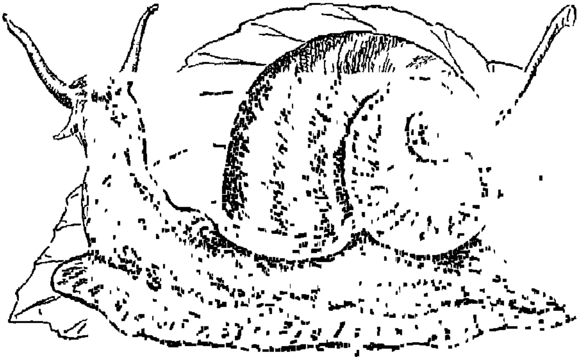


Fig. 61. Land snail.

find some snails living in water and some outside the water in nearby damp places. Collect some live land snails and bring them to your classroom. Take care to bring the snails found inside the pond, along with some water from the pond. The snails found on land may be brought wrapped in a wet cloth.

Take a land snail and observe its shell from outside. It is twisted and is made of one piece. The shell is the animal's house. The snail cannot move away from its house of shell. It carries its shell wherever it goes. The snail has built its house by certain materials produced in its body. Do you find a circular door to the snail's house? But the door is tightly shut. You might even think that the animal inside is dead because the closed shell appears to hold no life.

Movement

Leave the shell on a glass plate and quietly watch it. The door of the shell opens and the snail peeps out. Then it starts moving. Watch the movement of the snail. You might find it moving very slowly. You can find the reason, if you study the snail's foot. The main part of the snail's foot is also its belly. It really moves on its belly. Naturally speed is not possible. Lift the glass plate with the animal on it over your head and observe its movement from beneath the glass. You can observe a wave of contractions passing through its foot.

Observe the path of its movement. It leaves a trail of slimy liquid behind. The snail deposits a small amount of fluid at its front end and then walks smoothly over the fluid.

esponse to Stimuli

Let us find out as to how a snail responds to salt. Sprinkle some salt powder on its way. You will find that the snail senses the presence of salt. It avoids the direction of the salt and moves in a different direction.

Touch the snail with a pencil and see what happens. The nail draws its belly foot back into its shell. Since there are no bones or any hard part, it can shrink its body and get its foot and head inside the shell. Though the snail moves very slowly, it can pull back its foot and belly very quickly.

Again patiently wait and see how the animal slowly brings its body out of the shell. This time observe its head closely. You cannot mistake its head. It is at the front end of its foot. You might be surprised to know that it has no ears, no nose or snout. But it can still see and feel. How does it do this ? The head of a land snail bears four small projections. These are called **tentacles.** Closely observe the base of the pair of tall tentacles. At the base of each tentacle is attached an eye with a stalk. Thus the snail has a pair of stalked eyes. A snail can bend and turn its eye-stalk in different directions and thus see all around. But the snails see things poorly. The two pairs of tentacles are sensitive to touch. The snail waves them around and feels things around. It moves forward guided more by its feelers than by its eyes.

Feeding

Snails spend much of their time feeling around in search of food. Most land snails eat plant materials. Some snail are known to eat earthworms and the flesh of other animal Most fresh water snails live on algae. Keep some fresh wate snails either in an aquarium or in a bottle containing fres water and some algae. Observe how they move and eat th algae.

§ 2. FRESHWATER MUSSEL

You have seen that snails have different kinds of shells But all snails have twisted shells. Each animal has a shell made of one piece. There is another kind of soft-bodie animal bearing outer shells. The shells are made up of tw halves. These animals have no distinct head as in snail Such animals include the mussels, clams and oyste

These occur in seas and fresh water. The most common and easily available among the soft-bodied animals with two shells is the freshwater mussel.

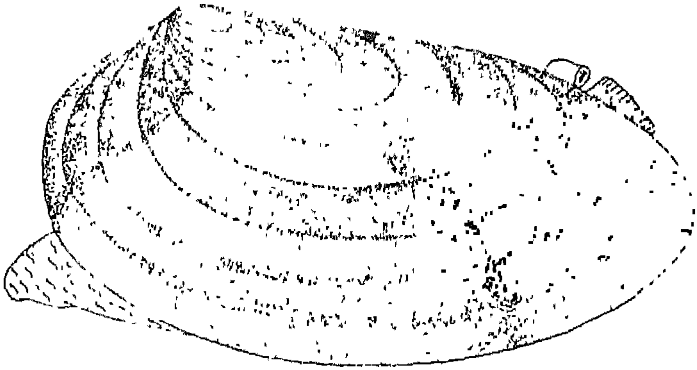


Fig. 6.2. Freshwater mussel.

Movement and Feeding

Freshwater mussels are found in lakes, ponds and rivers. Obtain a few live freshwater mussels and leave them in any large glass vessel containing sand and water. When undisturbed the mussels lie partly buried in the sand or mud with the lower part of their shells kept partly open. Through this opening the animal projects out its fleshy foot. By working the foot the animal slowly moves in the sand or mud. If you carefully observe, you will be able to find out how the animal moves in sand. First the animal projects out its foot. Then the free end of the foot gets swollen. This anchors the foot firmly in the sand. Then the muscles of the foot contract, and draw the body of the mussel forward. It is natural to expect that such a slow moving animal with the heavy shell on it will not be able to quickly reach its prey. Therefore, mussel has a very interesting mode of obtaining its food. It draws water through its body and filters the minute particles of food and living organisms contained in it. If you carefully observe the top portion of the animal at its back, two openings will be seen. Through one of its openings—the **inhalant siphon**—water current is drawn in and through the other opening called the **exhalant siphon** the water is expelled.

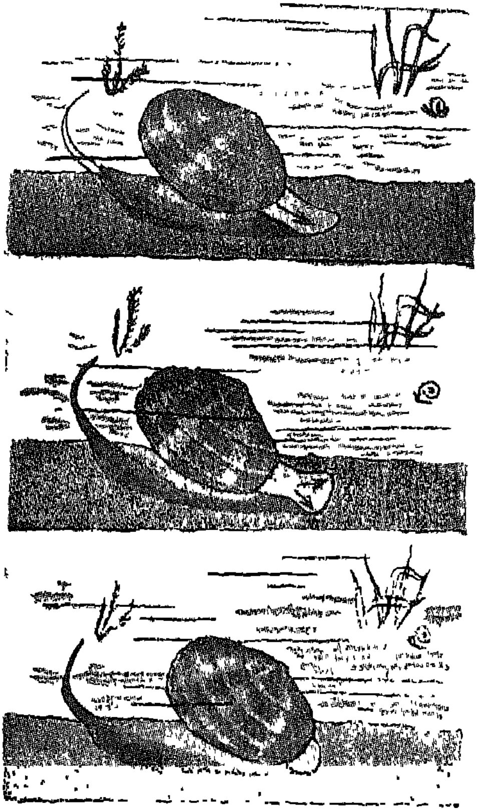


Fig. 6.3. Locomotion in a freshwater mussel.

Structure

Take out a mussel from the water and observe its shells. Try to open the shells. Do you find the shells tightly closing the body of the animal? Now you will realize how difficult it is to open the shells. How are these shells so tightly closed? They are closed by the contractions of two large muscles. Remove one of the shells from an animal that has been killed. Observe its inside. You will find two scars. These are the points of attachments of the muscles that close the shells.

Examine and see how these shells of mussels are different from the shells of snails. Each shell of a mussel as you have seen is made of two valves. They are not twisted like the shells of snails. The two valves are joined together by a tough ligament at the upper side. Each valve has a distinct swelling, the **umbo.** The umbo is encircled by a series of concentric lines. These lines are the lines of growth. As a mussel grows older new materials of the shell are made and deposited by the body on the shell. Thus the length and breadth of the shells increase with the increase of their age. The shining inner layers of the valves are called **mother-of-pearl.**

Examine the internal parts of a mussel. You can see the prominent fleshy foot, a pair of gills on either side, and two groups of muscles. These muscles that help in opening and closing the valves are called adductor muscles. The gills are the respiratory organs. The digestive, circulatory and nervous systems are situated deeper in the body.

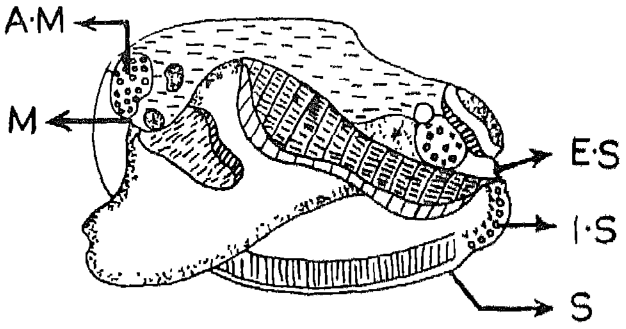


Fig 6 4. Freshwater mussel : One of the shells removed exposing the internal organs. A.M.—Adductor muscle ; I.S.—Inhalant siphon ; S—Shell ; M—Mouth ; E.S.—Exhalant siphon.

§ 3. SQUIDS AND CUTTLE-FISHES

Certain sea molluscs appear very different from either snails or mussels. These animals are called **cephalopods.**

Cephalopod means 'head-footed' animals. In these animals the head is surrounded by the foot which is in the form of arms. Cuttle-fish, squid, and octopus belong to this group.

Cuttle-fishes and squids have a conical body with ten arms. The arms bear disc-shaped structures called **suckers.** The arms with the suckers are used for capturing the prey and attacking enemies. Unlike the snails and mussels, squids and octopuses move in water with great speed. Squids and cuttle-fishes have skeletons inside their bodies. They also have ink sacs inside their body in which ink is produced. When attacked by their enemies, the cuttle-fishes discharge a cloud of ink and escape away from them. The giant squids, the largest living animal without a backbone, may be fifteen or

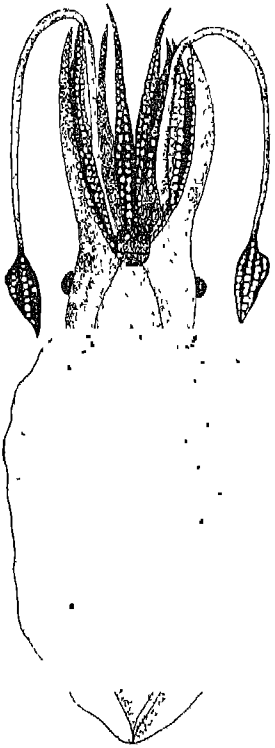


Fig. 6 5. Cuttle-fish

more metres long. Such a squid sometimes attacks even the mighty whales.

Octopus

Octopuses have rounded bodies, each with a pair of prominent eyes and eight arms. They have no internal skeletons. Small-sized octopuses are often found amongst the rocks at the bottom of seas. Giant octopuses might prove dangerous to divers. When the divers go underneath the sea in search of pearls or for exploration, the giant octopuses might hold them firmly with their arms and suckers. The divers may not be able to escape from the grips of these animals and come up to the surface. In such instances, even if the divers carry breathing equipment, the oxygen might get exhausted and the divers might drown in the sea.

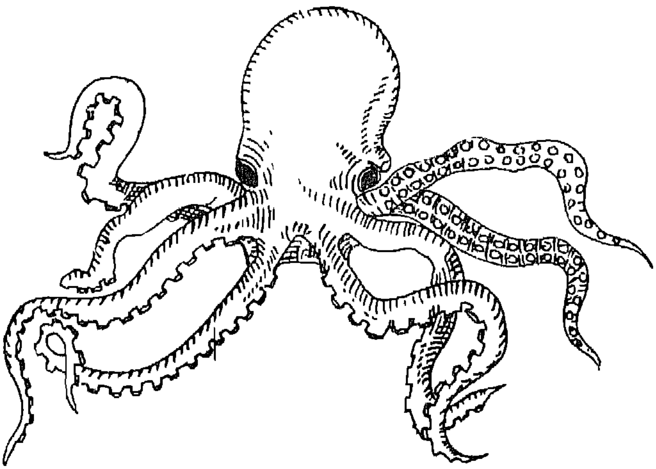


Fig. 6.6. Octopus

Useful Molluscs

Some molluscs are useful to man. From the shells of certain kinds of fresh water mussels buttons are manufactured. Certain oysters yield highly valuable ornamental objects, the pearls. The pearls secreted by the oysters are found between its shell and the mantle. In our country, pearl oysters are periodically fished out in the Gulf of Mannar off Tuticorin and in the Saurashtra coast. Thousands of osyters are opened to find one pearl. Lime, useful in building constructions, is obtained by burning shells of clams, oysters, etc. The colourful pearly layer of the shells of certain molluscs are made into jewellery. The beautiful shells of molluscs are polished and used as ornamental objects. The flesh of certain clams, mussels, oysters and cephalopods are eaten by some people.

Harmful Molluscs

A kind of snail without any shell is called slug. Slugs eat plants and thus cause great damage in the vegetable gardens. A noted harmful mollusc is the woodboring clam (Fig. 6.7). These are commonly known as shipworms though they are not worms. The shipworms have a long bodies with two small

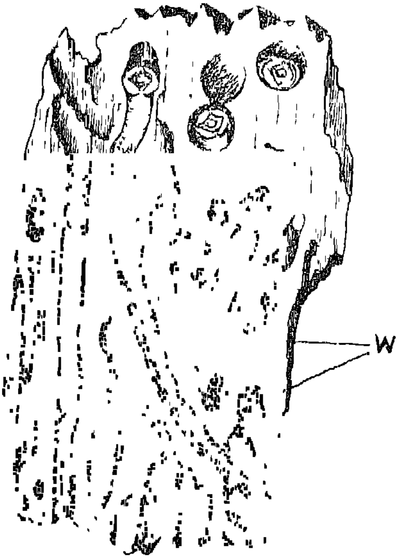


Fig. 6.7. Shipworms. The damage caused by the worms in the wood W—Worm.

shells in front. With the help of these shells the clams bore wooden materials kept in backwaters and the sea. They feed on the wood particles and thus cause great damage to wooden bridges, boats, ships and other materials.

Thus molluscs as a group of soft-bodied animals include many snails with beautiful shells, and useful animals. Unfortunately in our country the maximum use from these animals is not made. In certain countries like Japan, the United States, Canada and France the various kinds of useful molluscs are regularly fished from the seas and fresh water. Some of the edible molluscs are raised in special farms constructed in the backwaters, sea and on land. The collection of useful molluscs on commercial scale is called molluscan fishery. Molluscan fishery is yet to be developed in India.

SUMMARY

Mollusca is a group of soft-bodied animals with shells. The nature of their shells and foot differ in different kinds of these animals. A snail has a twisted shell of one piece and uses its belly as its foot. The shell protects the delicate internal parts. Some snails eat the flesh of other animals. Many snails live on plants.

Fresh water mussel has a shell made of two valves. It lives partly buried in sand. It feeds by filtering minute organisms and particles suspended in water.

Squids, cuttle-fishes and octopuses are fast swimmers. They have arms and suckers useful in capturing their food or in attacking their enemies.

Some molluscs are eaten as food by man. Products like buttons, pearls, lime, shell rings and bangles are obtained from certain molluscs. Some molluscs cause great damage to vegetation in gardens and wooden materials in the sea and backwaters.

Questions

1. How are the movements of a freshwater mussel and a snail different ?

2. Why do you find it difficult to open the shells of a live freshwater mussel ?
3. How are molluscs useful to man ?
4. How is the body of freshwater mussel adapted for its way of life ?

Tasks

1. Examine the movement of a snail in the classroom.
2. Collect different kinds of shells of molluscs and exhibit them in the classroom.
3. Collect the different kinds of useful products obtained from molluscs.
4. Remove one of the shells of a freshwater mussel and observe its internal organs.

CHAPTER VII

Arthropoda

Arthropoda is a large group of animals. You meet the members of this group everywhere, in houses, on trees, on roads, in the fields, in oceans, in forests and even below the soil. Butterflies, ants, bees, flies, mosquitoes, bugs, scorpions, spiders, prawns, lobsters and crabs are all members of this group. This is quite a big list! You may be surprised to know that animals so unlike each other are gathered into one group. There is one common feature among all these animals. They all have jointed legs. Their legs appear to be made up of separate sections joined together.

Take a look at the pictures of these different animals. Some of them resemble one another more closely than others. In order to understand the group better, the biologists grouped those that resembled one another closely into smaller groups. Thus arthropoda is divided into three groups. The prawns and lobsters belong to *crustacea*, all insects are grouped under *Insecta*, and animals like scorpions, spiders, ticks and mites are placed under *Arachnida*.

§ 1. CRUSTACEA

Prawn

Prawns live in fresh water or in the sea. They are found in rivers, reserviors, ponds and tanks.

External Structure

The prawn is covered with an external shell-like piece which forms its exoskeleton. This gives protection to its body. Carefully observe the body of a prawn. It has two distinct parts. The front part or the anterior one is the *cephalothorax* and the posterior portion is the *abdomen*. The former is covered with a shell which ends in a pointed spine-like structure. There are two eyes one on either side of the shell. The eyes of this animal are different from the eyes of many other animals. Each eye is made up of a large number of small units. Such an eye is called a compound eye. Many arthropods have compound eyes. There are thirteen pairs of small

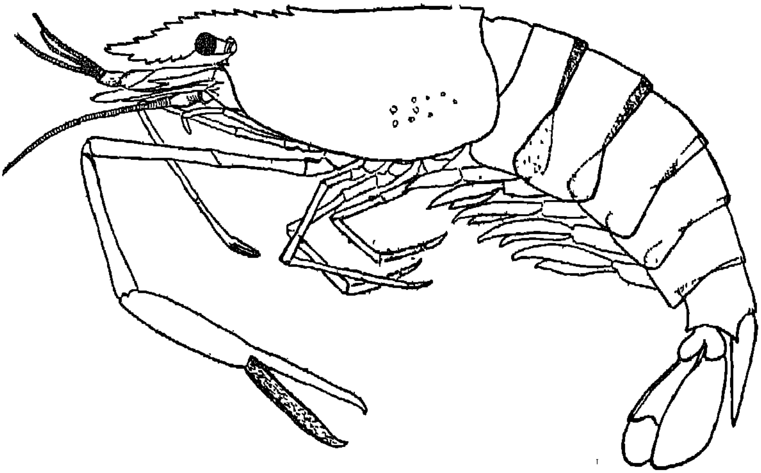


Fig. 7.1. Prawn.

jointed parts attached to the anterior part or the cephalothorax. The most prominent among them are a pair of walking legs. Are all the pairs of walking legs similar? Yow will find that the second pair of walking leg is much larger than the remaining ones. What other difference do you find in the legs? The first and the second pairs have pincer-like ends. The legs are useful to the animal in seizing its food and attacking its enemies.

The abdomen is made up of six segments. Each segment of the first five segments of abdomen bears one pair of legs. These legs are different in appearance from the walking legs. These legs are useful for the animal in swimming, and so they are called swimming legs. The last segment of the abdomen has a fan like tail fin. The tail fin is useful for the animal in its sudden backward swimming.

The prawn eats algae and other aquatic weeds and small animals. The female prawn carries eggs outside on the abdomen till the young ones hatch out of them.

There are different kinds of prawns. They are found in freshwater, brackishwater and in the sea. Small prawns are sometimes known as shrimps. Lobsters that live in the sea resemble prawns in certain respects. Lobsters often have beautifully coloured exoskeleton. They are found in rocky shores. They are much larger in size than the prawns. Lobsters and prawns are relished as food by some people.

Crab

There are many kinds of crabs. If you had visited a sea shore you would have found several crabs running to places of safety as you walked along the sandy beach. The crabs live in sea or in brackish water and some in fresh water. There are also land crabs which live in burrows spending part of their life in water for feeding and breeding.

External Structure

A crab has five pairs of legs. The legs of the first pair are large and strongly built. These legs are useful for seizing and tearing food and for attacking enemies. The body is

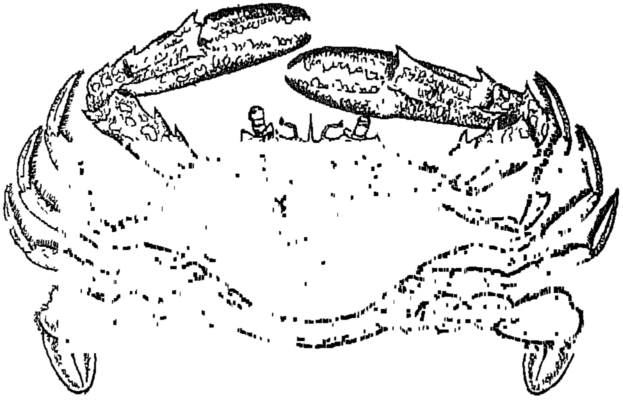


Fig. 7.2. Crab.

covered on its upper side with a large shell, known as *carapace*. The abdomen can be seen as a small folder part on the lower side of the body. A pair of compound eyes with stalks is present. They can be raised or lowered.

Different kinds of crabs have different colour patterns. Marine crabs are more beautiful than the freshwater ones. It is interesting to observe crabs on a sea shore running forward, sideward and backward.

Economic Importance of Prawns and Crabs

Prawns are eaten by some people in our country. They are considered to be delicious. The bulk of prawns are caught from the sea on the west coast of India. Prawns in the frozen and canned form are exported to the U.S.A., Burma, Ceylon and other countries. Prawns are caught only in certain seasons and the demand for them is greater than the supply. Hence prawns are costly.

The crab landing is also seasonal. The marine crabs are more popular, but compared to prawns there is not much demand for crabs.

Some other Crustaceans

The prawns and the crab are crustaceans. Let us know something of a few more crustaceans.

Barnacle

If you get a chance to go to the sea shore, examine rocks or

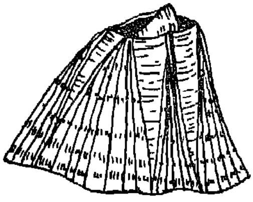


Fig. 7.3. Barnacle,

pieces of wood or iron or the bottom of the boat that has remained immersed in sea or backwater for a long time. You may find small conical shells attached to the wood or rock. There are openings at the top of these shells. The opening is closed by four plates. The body of the animal is inside the shell. This animal is called a *barnacle*. The bottom of ships and boats are often covered by large number of these animals. Even the shells of sea snails, oysters and sea turtles are covered with these animals.

Another kind of attached crustacean is the goose barnacle. It has a stalk bearing its body. The body is encased in a shell made of five pieces. Often small bristle-like parts project out of the shell of goose barnacles. When disturbed the animals quickly withdraw these parts.

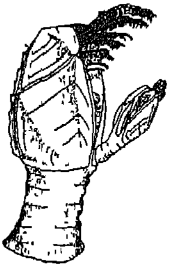


Fig. 7.4. Goose barnacle

Hermit Crab

There are some interesting animals called hermit crabs. The front or the interior part of these animals are protected in heavy coat of armour. But the back or the posterior part is soft and unprotected. To protect the soft part of its body, the hermit crab, crawls into an empty shell of a snail and occupies it. It drags its house wherever it travels. When it grows and finds its house too small, it abandons it and seeks a larger shell.

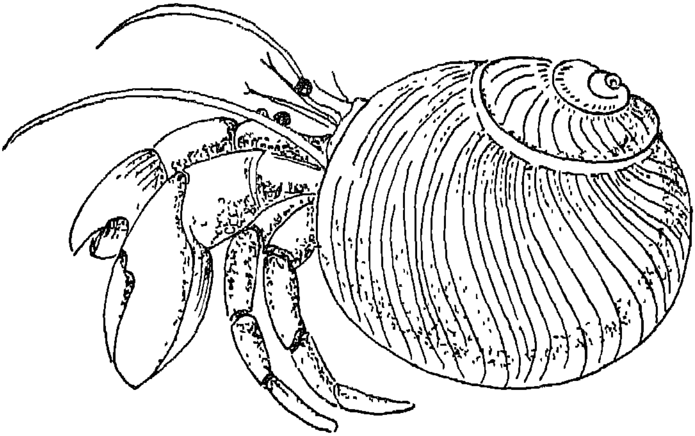


Fig. 7.5. Hermit Crab

Cyclops and Daphnia

A large number of minute organisms live floating in the surface layers of the sea and fresh water bodies. Such organisms are called plankton. These can be collected by sweeping a fine-meshed net in the water. These minute organisms form the food of fish and many other aquatic animals.

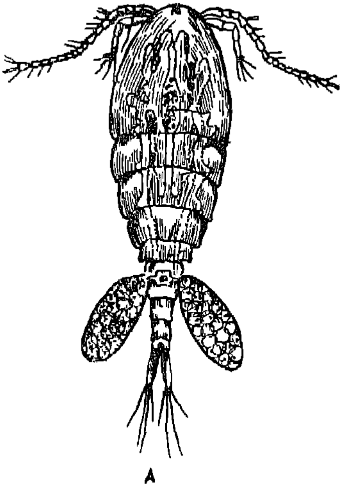


Fig. 7.6. A. Cyclc

Among the various crustaceans two forms are very commonly found in planktons. They are *copepods* and *Daphnia*. *Daphnia*, popularly known as water flea, is commonly found in fresh water ponds and ditches. It can be seen with unaided eye moving about in water as a small speck. The various parts of its body can be seen only when examined under a microscope. It has a transparent body with a minute head bearing an eye. The body is enclosed in a transparent bivalved shell. It swims by rapid jerks of its antenna.

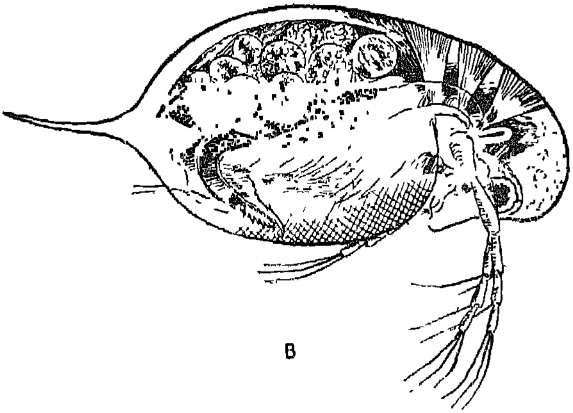


Fig. 7.6. B. Daphnia

Cyclops is a kind of copepod found in fresh water ponds and ditches. It is a minute crustacean. Its body is divided into a number of segments. It has two pairs of antenna and a single median eye. The female carries a pair of egg sacs, one on either side of its body.

The Importance of Crustaceans as Food of Fishes

Daphnia and *Cyclops* occur in larger quantities in tanks and ponds. Many young fishes depend on these for their food. If these animals become scarce then the fishes that depend on these, die in large numbers. Some fishes live on plankton. They filter them from the water and take them in. Some fish feed on prawns which in turn feed on *Daphnia* and *Cyclops*.

The two animals form a link in what is called a food chain. In water there are very minute, unicellular plants called diatoms. They abound in the plankton of the seas and fresh water. They have chlorophyll and are capable of making their own food like other green plants. *Daphnia* and *Cyclops* eat and thrive on diatoms. These small animals are in turn eaten by small fishes. The small fishes are eaten by large ones and finally man catches them and eats them. Thus the food chain is: Diatoms—Daphnia and cyclops—little fish—big fish—man.

SUMMARY

Arthropods are joint-footed animals. Crustaceans are a group of arthropods. Prawns, lobsters and crabs are among the most familiar crustaceans. These are used as food by some people. Some crustaceans like the barnacles and goose-barnacles lead a sedentary life. *Copepods* and *Daphnia* are small microscopic crustaceans found frequently in plankton. They form an important link in the food of fishes.

Most of the Crustaceans live in water. In many forms head and thorax are fused to form a cephalothorax. The number of appendages vary in different forms. All crustaceans have two pairs of antennae.

Questions

1. "Animals that differ greatly in their external features are put together in the group crustacea".
   (*a*) Give examples of some such crustaceans.
   (*b*) Point out how they differ very much from one another ?
   (*c*) What are the features that are common in all these forms so as to group them as crustaceans ?
2. (*a*) What is meant by the term plankton ? Mention two planktonic animals known to you.
   (*b*) How are plankton useful to fishes ?

Tasks

1. Examination of the external body features of a prawn and a crab.
2. Collection of the locally available crustaceans.
3. Collection of water samples and identification of *Daphnia* and *copepods.*

§ 2 INSECTA

Cockroach

Cockroaches are commonly found in houses. They live in our kitchens, store-rooms and inside our cup-boards. They prefer dark damp places where plenty of food materials are available. They remain hidden during day-time in holes and crevices and come out during nights. Such kinds of animals that become active during nights are called *nocturnal animals.* Cockroaches feed on different kinds of materials like clothes, vegetables, animal matter and sometimes even paper.

Some animals feed only on plant materials. The cattle, the sheep, the horse and some fishes are such animals. These are called *herbivorous* animals. Many animals like the wolf, tiger, lion and cat eat only other animals or their flesh. Such animals are called *carnivorous* animals. There are still another kind of animals that feed on all kinds of materials. These are the omnivorous animals. The cockroach is an *omnivorous* animal.

External Features

The body of a cockroach is divided into three regions; the head, thorax and abdomen. The head which is pointed downwards bears on its upper side a pair of eyes and a pair of long hair-like organs called antennae. The eyes are compound. The antenna helps the animal to feel small objects around it. The mouth parts enable the animal to scrape and bite or cut food materials.

The thorax is made up of three segments. Each segment has a pair of legs on its lower side. Carefully examine the leg of a cockroach. You will find that it is made up of parts joined together. Thus a cockroach has three pairs of legs. All insects have three pairs of legs. Cockroach is an example of an insect. Some insects possess wings in addition to three pairs of legs. The cockroach has two pairs of wings on its thorax.

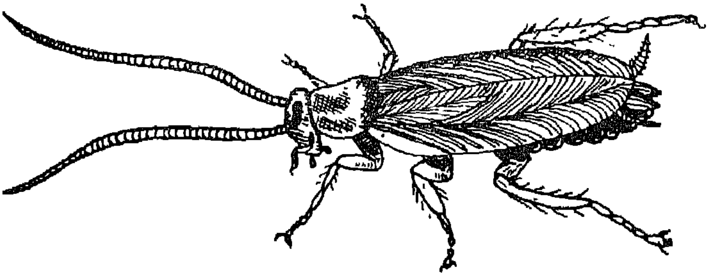


Fig 7 7. External characters of cockroach

The abdomen is made up of ten segments. Each of the first eight segments of the abdomen has a pair of minute openings called stigmata. These are the openings of the respiratory tubes. There are two pairs of such stigmata on the upper surface of the last two segments of the thorax.

Digestive system

The mouth leads into a buccal cavity in which the salivary glands open. There is a pair of salivary glands. The buccal cavity leads into the gullet which is a narrow tube. The gullet dilates into a sac-like organ, the crop. The crop has thin walls and helps in temporarily storing food materials. The organ next to the crop is the gizzard. The gizzard is thick-walled and has thickened hard structures to grind the food.

The mid-gut or the stomach is a wide tube with thin walls. At the junction of the gizzard and stomach there are seven or eight tubes called *hepatic caecae*. The inside wall of the stomach and the *hepatic caeca* secrete juices that help in digesting food.

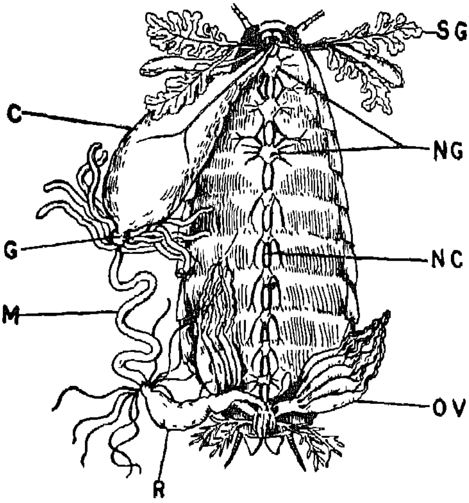


Fig 7.8. Internal organs of cockroach : S.G. Salivary glands; N.G Nerve ganglion , N.C. Nerve cord ; Ov. Ovary; C. Crop; G. Gizzard ; M Mesenteron ; R. Rectum

In the hind-gut which is a coiled tubular part, the digested food is absorbed. At the beginning of the hind gut there are tubules called *malphigian tubules.*

Respiratory system

Cockroaches respire with minute tubes called tracheae. There are two large tracheae lying at the sides of the body cavity. These tracheae open to the outside through the stigmata. Tracheae branch greatly and very fine branches called tracheoles penetrate all the tissues of the body.

The air from outside enters the tracheal tubes through the stigmata. It is taken to different tissues by the tracheoles. The contraction and expansion of the abdomen, forces the air in and out of the body. The tracheoles have thin walls. The oxygen diffuses out of the tubes into the tissues. The waste product, carbon dioxide, that is formed in the tissues enters into the tracheoles and from there it is eliminated through the stigmata.

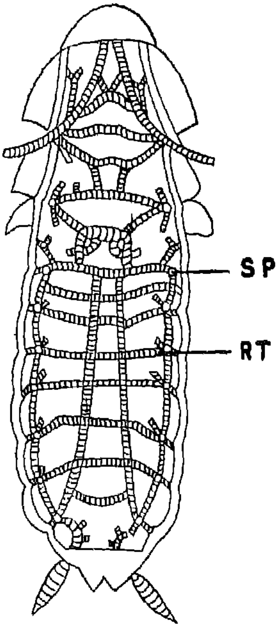


Fig. 7.9. Respiratory system in cockroach. Note the tracheae.
R. T. Respiratory tubes (tracheae); Sp. Spiracle

How is this method of respiration differnt from that found in earthworms? In cockroaches the air is directly carried to all parts of the body. The blood does not carry the oxygen to different parts of the body. You have learnt that in an earthworm the oxygen that diffuses through the moist skin is taken to different parts of the body by the blood.

Circulatory System

You have seen that the body of an earthworm is made up of two tubes. One tube is within another. The alimentry canal is one tube. This is enclosed in another tube, the body wall. In earthworm the blood is enclosed is minute tubular vessel. These vessels carry the blood containing oxygen and food materials to different parts of the body.

In cockroach, the blood is not contained in closed blood vessels. The body cavity of cockroach is filled with organs and these bathed in the blood. You always think of the blood as red in colour. In cockroach the blood is colourless.

How does the blood circulate in 'cockroach'. The circulation of the blood is maintained by a heart situated at the ventral side of its body. The heart is tubular and is divided into thirteen chambers. Each chamber is connected with the one in front through an opening guarded by a valve. When each chamber contracts, the blood is driven into its front chamber. The backward flow of blood is prevented by the valves. The heart is enclosed in a membrane. The contraction and relaxation of these muscles causes the blood to enter into the heart through openings. Thus the action of the muscles and the heart maintain blood circulation. The blood absorbs the nutrient material from the digestive canal and carries it to all parts of the body.

Excretory System

At the beginning of the hindgut, there are a number of minute, thread-like tubular glands, called *malphigian tubules*. They separate the waste products from the blood. The separated waste products are passed into the intestine from where they are passed to the exterior through the anus.

Nervous System

The nervous system is somewhat similar to that found in earthworms. There are two pairs of ganglia situated in the head. One pair lies above the oesophagus and the other pair beneath it. All these four ganglia form a ring. The upper pair of ganglia is the brain. The brain does not seem to co-ordinate the movements of legs and wings. Even after the removal of the brain, a cockroach can, walk, jump or fly. The brain serves mainly to co-ordinate the functions of the sense organs like eyes, antennae, etc.

From the ring of ganglia, a double nerve cord, passes along the whole length of the body. The nerve cord is thickened into a ganglion at intervals. There are in all nine ganglia. From each ganglion nerves arise to supply different organs of the three thoracic and the first five abdominal segments. The last ganglion is formed by the fusion of four ganglia. This supplies the last four abdominal segments with nerves.

The Reproductive System

Unlike the earthworms, there are separate male and female cockroaches. The reproductive organs of a male cockroach consists of a pair of testes, vas deferens, mushroom-shaped glands etc., the two seminal vesicles to form a duct opening to the exterior.

In a female cockroach there is a pair of large ovaries. Each ovary is made of eight elongated finger-shaped ovarian tubes. Each ovarian tube has a number of ova in it. Each ovary is continued backwards into a short and wide oviduct. The two oviducts unite to form a wide common oviduct which opens to the outside through an opening.

§ 3. SOME COMMON AND INTERESTING INSECTS

There are many different kinds of insects. There are more varieties of insects than all the other varieties of animals put together. Can you imagine how many kinds of insects are there in this world ? There are more than 600,000 kinds of them. You cannot possibly learn about all the insects. But you should know which of the animals, you frequently see in your surroundings are insects. Though the insects are of different kinds, there are certain features common to all insects.

An insect when it is fully grown has three pairs of legs. Its body is divided into three parts the head, the thorax and the abdomen. It has a pair of antenna or feelers. Some insects have in addition, one or two pairs of wings.

Butterflies and Moths

You would have seen butterflies visiting flowers. Butterflies belong to a group of insects called the 'scaly-winged insects'. Their wings are covered with minute scales. Touch the wing of a butterfly with your finger. You will find some brilliantly coloured powder substance sticking to your fingers. Rub the substance on a clean slide and examine it microscopically, you will be surprised to find the scales. Silk moth also belongs to this group of insects. What are the differences between moths and butterflies ? You can easily distinguish a butterfly from a moth. A butterfly flies about during the day; moths mostly fly at night. Butterflies keep their wings straight up and folded, when they are resting. Moths keep their wings spread out, while resting. Butterflies have knobs at the tips of their antenna. Moths lack these knobs. In many cases the antenna of moths are feathery. Butterflies are brightly coloured while moths look dull in colour.

Moths and butterflies visit flowers in search of nectar. They suck the nectar through their long tubular mouths. When not in use the mouth tube is kept coiled like a watch spring.

Grasshopper

You would have seen grasshoppers hopping about in the fields and lawns. Count and see the number of legs they have. The last pair of legs are adapted for hopping. Have you heard grasshoppers making noise ? They make noise not through their mouth but by rubbing to-gether the legs and wings. Grasshoppers have a peculiar habit of cleaning their face with their front legs.

Grasshoppers have strong jaws The jaws help in cutting and chewing the leaves.

Praying mantis

You might have occasionally seen a praying mantis. Do you know why it is called a praying mantis ? Because of its peculiar habit of holding its two forelimbs folded. On such occasions it appears as if it is praying. The forelimbs of praying mantis are very strong. It catches with its forelimbs and eats insects like butterflies, grasshoppers, flies and mosquitoes.

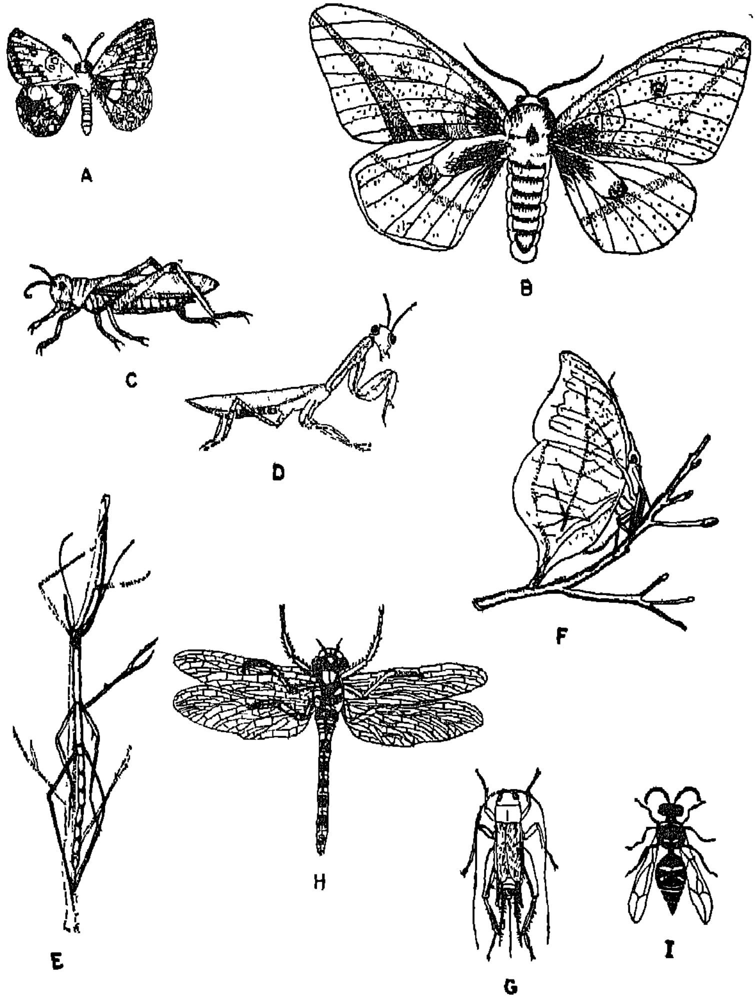


Fig. 7.10. Some insects : A. Butterfly ; B. Moth ; C. Grass hopper, D. Praying mantis ; E. Stick insect ; F. Leaf insect, G. Cricket, H. Dragon fly ; I. Wasp

Stick insects

Stick insect is sometimes called as a "walking stick". In outward appearance it is very much like a twig. Stick insects secrete a foul smelling substance from glands in the thorax. Perhaps this smell keeps away certain animals that are harmful to stick insects. Unlike most insects a stick insect can regrow its lost legs.

Leaf insect

The wings of leaf insects are green and resemble certain leaves. The legs often have leaf like expansions. It is very difficult to find out the leaf insects when they are in the midst of leaves. This adaptation protects these insects from their enemies.

Crickets

Crickets are small insects that are found very often in our houses, storage places etc. They can run fast and jump well. Have you heard crickets making chirps ? It is only the male crickets that make the noise with their wings. Female crickets are noiseless. The noise is produced by the rubbing of their wings.

Dragon flies

Dragon-flies are commonly seen flying near ponds and resting on plants. They have slender body and prominent head bearing two conspicuous compound eyes. The two pairs of their wings are always kept stretched ; they can never be folded. Dragon flies live on other small insects, flies and mosquitoes. They catch and eat their prey while flying.

Dragon flies lay their eggs on parts of plants, submerged in water. The young dragon flies spend a long period of about two years in water. They feed on other water animals including the young ones of fishes.

Wasps

Wasps are very interesting insects. One should be very careful while dealing with wasps, because they sting. The stings are very painful. Adult wasps generally feed on nectar or plant sap. Wasps construct nests, making use of either naturally occuring cavities or with mud. After the nest is ready the wasps go in search of either caterpillars or spiders. These wasps sting their victims and paralyze them. The paralyzed bodies are carried by the wasps to the nest. They deposit eggs on the bodies of the caterpillars and seal the nests. The eggs hatch out and feed on the caterpillars. Some wasps live in group as social insects.

§ 4. REPRODUCTION AND DEVELOPMENT IN INSECTS

You have learnt that in *Hydra* and in some worms, both the male and the female reproductive organs are present in the same individual. But in insects the sexes are always separate i.e., the males and the females are separate. You have already learnt about this in cockroaches. All insects develop from eggs. In most insects like cockroaches, grasshoppers, dragon flies and butterflies, the eggs are laid at first and then the young ones hatch out from the eggs. In a few insects the eggs develop within the body of the female, and live young ones are produced.

The eggs of insects are minute in size. The eggs are spherical, oval or barrel shaped. Insects lay their eggs in different places. The butterflies and moths lay their eggs on the parts of plants. Grasshoppers lay eggs underneath the soil. The dragonflies lay their eggs in water which are often attached to water plants. Wasps lay their eggs inside the body of other animals like spiders and caterpillars.

Generally insects lay eggs in clusters. Some insects like cockroaches and grasshoppers enclose their eggs in a special covering. You will often find the egg-cases of cockroaches deposited in the crevices of your ward robes, wooden boxes and such other things.

The development of a butterfly can be studied by collecting its eggs and rearing them in small boxes or bottles. You may be able to collect the eggs of one kind of butterfly from the undersurface of the leaves of *madar* (*Calotropis*). Minute worm like young ones hatch out of the eggs. These feed greedily on the leaves of *madar* and grow big rapidly. If you are rearing some of these caterpillars in a box, you must supply them everyday with enough of fresh *madar* leaves. Carefully observe the caterpillars every day. One day they stop feeding and cover their body with minute thread-like things. Then the caterpillars seem to have escaped as you may not find any. Instead of the caterpillars you might see small bubble like things hanging from the tops of your box or bottle. If you patiently wait for a few more days, you would see beautiful

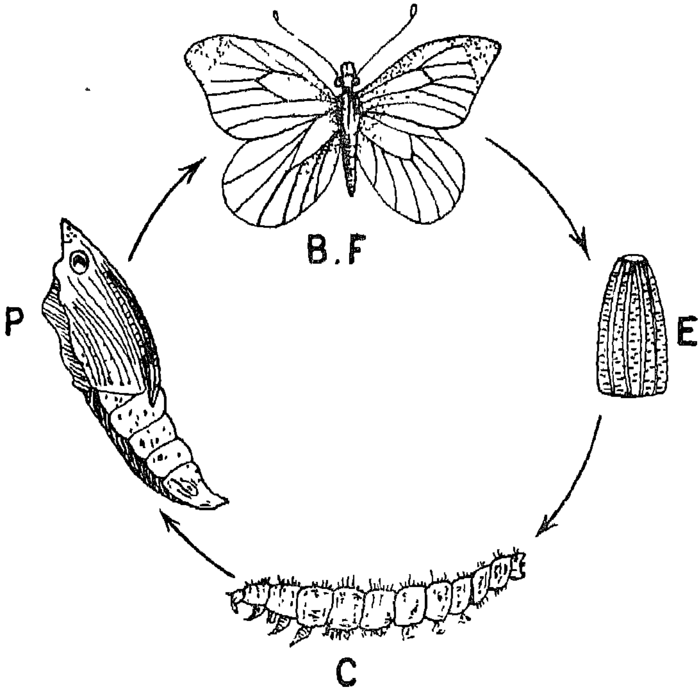


Fig. 7.11. Life cycle of butterfly : E. Egg ; C. Caterpillar ; P. Pupa , B. F. Butterfly

butterflies coming out of them.

Now compare an adult butterfly with a caterpillar. Do you find any similarity between the two ? The young one of the butterfly is a worm like living creature. It is very much different from the adult butterfly. The butterfly has a coiled tubular mouth, whereas the caterpillar has a biting mouth. The number and nature of legs in caterpillar are very different from those of the adult butterfly. The adult butterfly has wings which are completely absent in a caterpillar. A caterpillar is the young one of an insect from which it differs very much in appearance. The young one is called the larva of the insect.

The caterpillar is a leaf eating worm-like creature which is not able to fly. The butterfly on the other hand is capable of flying and sucks liquid food. Before a caterpillar can become a butterfly, many changes take place. The entire series of changes that take place during this development is called metamorphosis. The different organs and the nature of life itself change.

The extent of metamorphosis differs in different insects. In cockroaches the young ones resemble very much an adult except for the size, colour and absence of wings. Such young ones are called nymphs which gradually grow and become adult.

§ 5. HARMFUL INSECTS

Through living their own lives some insects are harmful to us. By attacking our crop plants some insects greatly reduce the yield. Other insects cause great damage to our forest products, food grains and garden plants. Certain others carry disease causing germs and thus spread the disease among the population. There are thus two broad categories of harmful insects (*i*) The carriers of our disease causing germs, and (*ii*) the insect pests of agriculture.

INSECTS AS CARRIERS OF DANGEROUS DISEASES

Insects like house-fly, mosquito, flea and louse are known to carry germs that cause certain diseases.

House fly

You might have seen your mother keeping cooked food materials covered. Do you know why ? They are covered to keep off flies and dust. After all the flies do not take away much of the food. materials. Then why does mother cover them ? Flies sit on all kinds of things. They might sit on human excreta. They also eat many different kinds of food. During their search for food, they might by chance sit on the faecal matter of a person suffering from cholera. In such cases the flies carry the cholera germs which stick to their feet. When the flies subsequently sit on food materials, the germs from the feet of the flies might be transferred to the food. Thus the food gets contaminated with cholera germs. When healthy person eats this contaminated food, he is likely to suffer from cholera.

In a similar way the house flies help in spreading many other diseases like dysentery and typhoid. The flies help in spreading the disease rapidly among human beings. If our food materials are kept away from the flies the diseases can be checked. The spread of these diseases can be checked by preventing the flies from increasing in large numbers. Flies lay their eggs in places where rubbish materials are heaped By keeping our surroundings clean the incidence of these diseases, can be kept down.

Mosquito

Have you seen people sleeping under a mosquito curtain ? Why do they do so ? Mosquito bites are painful and cause you loss of sleep. By sleeping under the net you prevent mosquito bites. Mosquitoes fly about in large numbers mostly during nights. Malaria is caused by certain one-celled animals.

The mosquitoes help in spreading the disease among us by their bites.

There are many other diseases that are spread by mosquitoes. Filariasis is another disease that is spread by mosquitoes.

The way the mosquitoes spread the germs amongst us is different from the way the house flies spread cholera. When mosquitoes suck the blood of a person suffering from a disease like malaria or filaria, the germs causing these diseases get into the body of the mosquitoes along with the blood. Inside the bodies of the mosquitoes the germs grow rapidly and increase in numbers. When such a mosquito bites a normal person, some of the germs get injected into his body and might make him get the disease.

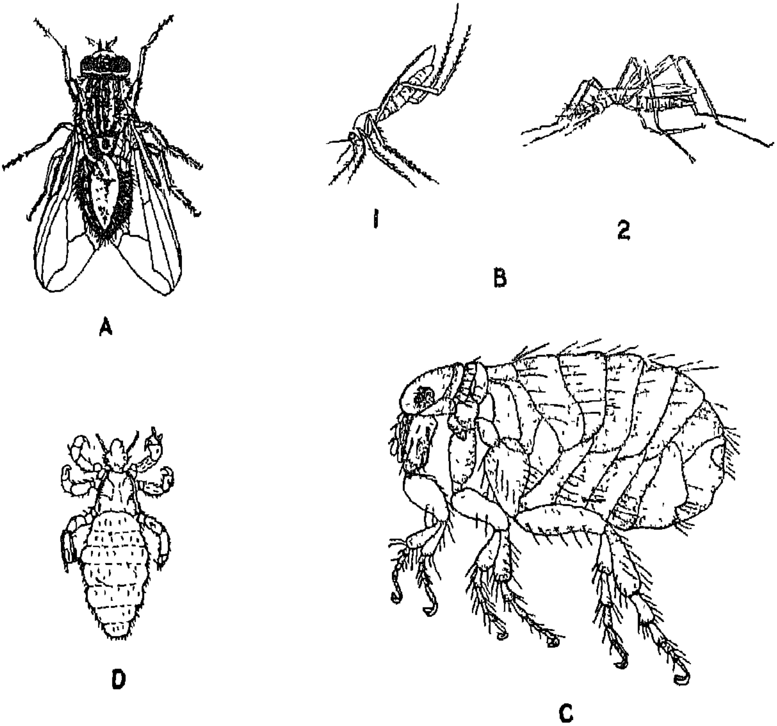


Fig. 7.12. More insects: A. Housefly; B. Mosquito: 1. Anopheles; 2. Culex; C. Flea; D. Head louse.

There are different kinds of mosquitoes. It is very often only a certain kind of mosquito that can spread a particular disease. Malaria, for example, is spread by the female *Anopheles* mosquito. You can find out an *Anopheles* mosquito by looking at it when it sits. When an *Anopheles* mosquito sits on anything, its body is raised at an angle to the surface. It is only the female *Anopheles* mosquito that can spread the disease. The male Anopheles mosquitoes feed on plant juices. The have biting mouth parts. The female mosquitoes have a piercing tube through which they suck blood from human beings. Culex is another type of mosquito, whose body is parallel to the surface on which it sits. Culex are known to spread filariasis in certain places.

Flea

Fleas are minute insects. They live as parasites on animals like rats. Certain bacteria cause plague in rats. The rats suffering from plague contain these bacteria in their blood. When they suck the blood of rats suffering from plague the fleas get infected with plague-causing bacteria. The ailing rats die quickly. The fleas on these rats leave the body and might bite human beings. While sucking the blood of human beings the plague-causing bacteria get an entry into their body. Thus man gets plague. Plague can be avoided if the fleas are eliminated.

Louse

Two kinds of lice live on our body. One kind is the head louse living on head concealing between hairs. The other kind is the body louse clinging to our dress. Both kind of lice feed on the human blood. They rapidly increase in numbers if the body and head are not cleaned properly. The blood of persons suffering from certain disease contain the disease-causing germs. The lice suck the germs along with the blood. When people crush lice on the body, head or between the nails, the germs come out. These germs might get into the body of normal persons through the wounds or puncture made by the lice and cause the disease.

§ INSECT PESTS OF AGRICULTURE

You might have seen some living worms inside vegetables when they were cut before cooking. Some worms are found inside apples and beetles inside mangoes.

What are these worms ? They are not parts of the fruits or vegetables ! How did they get into the vegetables and fruits ?

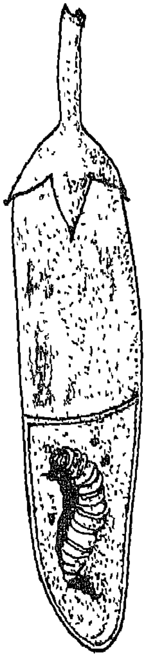


Fig. 7 13 A worm in brinjal.

The worms you find inside the fruits and vegetables are the young ones or the larva of certain insects. These insects lay eggs inside the fruits before they develop. The young ones hatch out of the eggs in the tiny fruits and develop when the fruits grow big. They feed on the food materials found inside. Thus they compete with us for food and deprive us of some of our food materials. We, therefore, think of these insects as our enemies or pests. We call those organisms pests that are not wanted by us and which are harmful to us. Pests destory our valuable products. The destructive insects are collectively called as insect pests.

Our vegetables and fruits are not the only food products that are badly affected by the insect pests. They attack our principal food materials like wheat, paddy, corn and millets and with the result the yield of these food materials are much reduced. The cultivators constantly fight against these insects.

Different kinds of insect pests can cause damage to our crops in different ways.

(*a*) The leaves and the stalks of plants are eaten up. When you take a walk along the fields you might have seen grasshoppers chewing the leaves of plants. Great damage is caused by locusts by chewing the leaves and tender shoots. Locusts usually fly in big swarms.

Once the locusts invade a field, the crops will be destroyed over vast areas.

(*b*) Certain insects suck the sap from plants. When plants are attacked by a large number of such insects, they wilt and finally might die.

(*c*) Sometimes you might not find any insect outside, but inside the stems of the plants large number of insect larvae might be found. These insect larvae bore the stems and destroy their internal tissue. This causes the death of the plants.

(*d*) Certain insects attack the products only. As a result of this the yield is greatly reduced.

(*e*) Some plants suddenly die. If the shoots of these plants are examined you may not find any insects, but you will find that their roots are destroyed.

(*f*) Have you ever examined closely the grains purchased from the market ? You will find holes in some of them. If you crush such grains, you may find insects inside them. These insect attack the grains in storage.

Plants have many kinds of enemies. Fungi, bacteria and virus attack them and cause great damage. We are more concerned with the cultivated plants, since we get our food materials from them. A number of plant diseases greatly reduce the yield. Insects still further decrease the yield of useful plants by their attacks.

Insect control

We know that some insects are harmful. If we eliminate completely these insects our total yield of food and other commercial products will be much more than what it is now. The total eradication of insects may not be possible. Whatever we do to get rid of the insects, they will still persist on this earth. It is enough if we stop the pest from becoming a serious one. That is why the term "insect control" is used.

Insects can be controlled in different ways. The two important methods are (1) chemical control and (2) the biological control. Chemicals are widely used in fighting against insects. No one chemical is helpful in fighting all kinds of insect pests. There are a large number of different kinds of chemicals used as insect poisons. All chemical poisons used for killing insects fall under two broad categories (1) contact poisons and (2) stomach poisons.

Some contact poisons are DDT, kerosene, and nicotine sulphate. A contact poison kills an insect when it comes in contact with the outside of an insect body. Such contact poisons are sprayed in places where insect pests are found.

Stomach poisons must reach the stomach of an insect before it can do any harm. Lime, sulphur and Arsenic compounds are some stomach poisons. They are mixed with food materials of the insect pests and left around places where the pests are found.

Biological control is a new way of fighting insects. Certain insects feed on harmful insects that destroy our crops. By introducing such insects, pests can be brought under control. Frogs, toads, lizards and many birds eat insects. Encouraging insect eating birds and other insect eating animals to visit frequently the fields is an excellent way of fighting insect pests. Certain insects or other organisms live as parasites on the bodies of insect pests. By introducing suitable parasites the insect pests may be controlled. Certain fishes feed on mosquito larvae. By introducing these fishes in ponds, wells and other stagnant waters, mosquitoes can be brought under control.

§ BENEFICIAL INSECTS

There are a number of insects that are helpful to man. Some of these insects yield so many useful products. Let us know these insects and the useful roles they play.

Bees

In a flower garden you might have seen honey bees hovering round the flowers. The bees visit flowers to get the nectar and also pollen from them. The nectar is taken to their hives and there it is converted into honey. Honey is a sweet liquid which is useful to us in many ways. It is used as food and also taken with drugs. In the olden days honey was the only important sweetening material. Bees wax, a product from the hive is used in the manufacture of sealing wax, polishes, varnishes, and other products.

Silk moths

The silk industry is a very ancient one. Silk worms are really the young ones or larvae of the silk moths. These worms build a cocoon which is a stage in their life-history. From the material of their cocoons silk threads are spun. Silk is woven by using these yarn.

Lac Insect

Shellac is obtained from a kind of insect called the lac insect. These insects secrete some materials to protect their delicate bodies. Lac insects are cultivated on particular trees

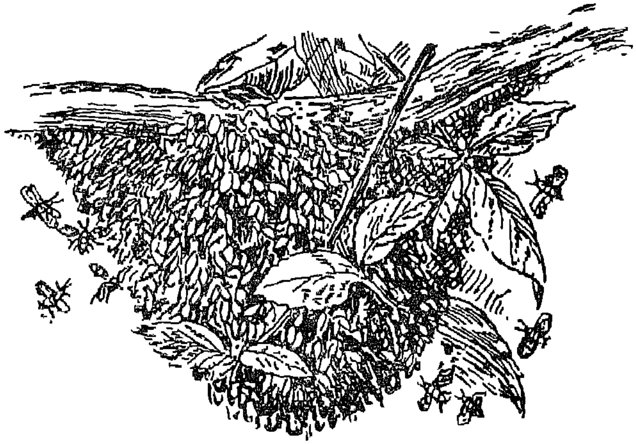
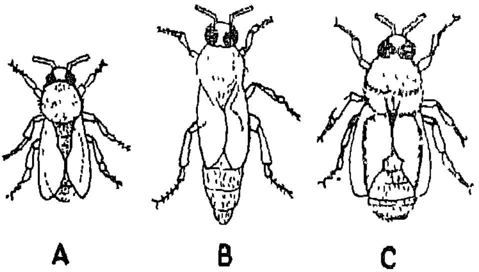


Fig. 7.14. Beehive

and this material in scraped and melted in boiling water and



7.15. Honey bee : A. Worker , B. Queen ; C. Drone

purified as shellac. This is useful in many ways. A red dye is also obtained from the lac insects.

Dye producing insects

Several insects have been used in the manufacture of dyes. Carmine, a red pigment is obtained from the *cochineal* insect. Carmine is not now used so much as was once done. Other dyes prepared synthetically have taken its place. Foods and drugs are still coloured with it. Carmine is used by biologists to stain some tissues for examining them. Cochineal insects live on prickly pear plants.

Drug yielding insects

Some insects yield useful drugs. A substance called cantharidine is obtained from the bodies of certain kinds of beetles. Cantharidine is rubbed on the skin in certain diseases. During World War I, it was accidently discovered that larva of certain flies helped in quickly healing the decaying tissues of bones. The study of how these maggots helped the bones to heal, led to the discovery of a substance, allantoin. At present allantoin is used in the treatment of certain bone diseases and deep wounds.

Insects as Pollinators of flowers

Insects play a great role in carrying pollen from flower to flower. There are many plants that are cross pollinated in nature only by insects. Bees, wasps, flies, butterflies, moths and beetles are the well known flower-pollinators. Especially bees are noted for their role in pollinating flowers. When insects visit flowers, pollen grains often stick to their bodies. Some of these pollens may be transferred to the stigma of other flowers during the subsequent visits of these insects. Very often a kind of flower is visited only by a particular kind of insect. This helps in bringing about cross pollination among flowers.

Other uses

Certain kinds of insects are eaten in some parts of India, *e.g.*, the termites are collected as they come out of their holes and taken as food.

Weeds are unwanted plants in the midst of some cultivated plants. Removal of weeds is necessary for the good growth of a crop or plantation. One of the methods by which weeds are eliminated is by using some insects which live on the weeds as parasites and eliminate them totally. One good example of this was the elimination of prickly pear by the cochineal insect. Prickly pear or cactus was once growing densely on vast areas of land. Some cochineal insects were introduced into our country. The cochineal spread wildly and destroyed all pickly pear bushes.

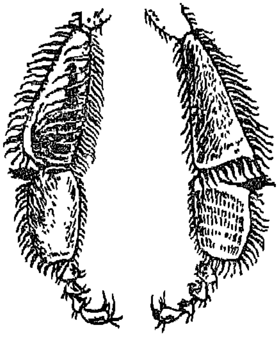
Biologists use insects in their experiments. They found insects easy to raise in large numbers in a short time. The fruit fly has been very much used in the study of heredity. An American biologist Dr. T. H. Morgan was awarded the Nobel Prize for his studies on the heredity of fruit flies. What has been learnt by these experiments has been found to be of great value in our understanding the heredity of man.

Social Insects

You are familiar with honey bees and the bee hives. A honey bee cannot live alone. Thousands of honey bees live in one hive. These honey bees do not simply live there, each looking after itself. They help one another and thus collectively work to maintain a hive. There are different kinds of bees in a hive. Each kind of bee performs certain kind of work. But all bees work for the welfare of the whole community in a hive. The bees are thus organized into groups. The different kinds of the group do different work. Such insects are called social insects. The groups of such insects are known as insects societies. Are the honey bees the only example of social insects? No, there are many more insects. Some of them are very familiar to you. Ants, termites and some wasps are other examples of the social insects.

Honey bees

Let us know something about the different kinds of honey



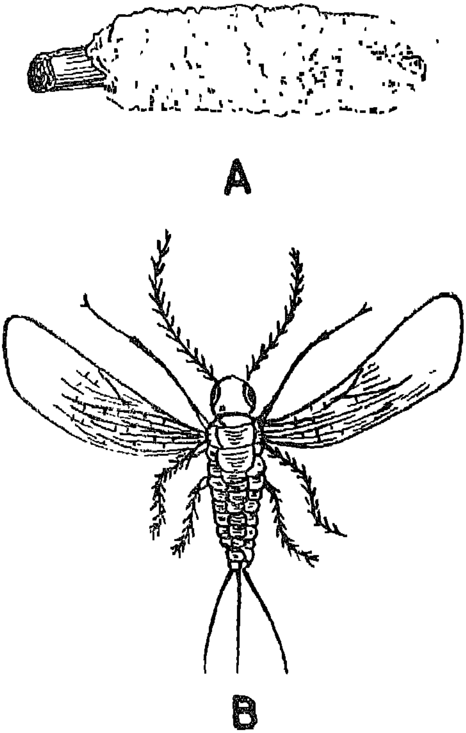
7.16. Pollen basket on the legs of a honey bee bees and the different kinds of work they do.

A colony of honey bees may be made up of as many as 80,000 individual bees. Out of these one is a *queen bee* and about 200 are *drones* and the rest are *workers*. These three kinds of individuals show differences in the structure of their bodies.

The workers : The workers are smaller in size compared to the drones and the queen. The workers have glands that secrete wax. They have the pollen basekets, in which the pollen grains are stored. The abdomen of the drones are broad but are shorter than that the of queen which is narrow and long (Fig. 7.16).

7.17. Silk Moth

You have observed the honey bees gathering nectar from flowers. This sweet juice is converted into honey by the bees. Collection of nectar from the flowers is done by the workers. Some of the workers bring pollen from the flowers. The workers carry the pollen on their hind legs. The parts of the legs in which the pollen grains are carried are called *pollen* *baskets.* These pollen baskets are made of stiff hairs. These stiff hairs hold the pollen on the bees' legs. After a bee has filled its pollen baskets it flies back to the hive. These bees use the pollen and the nectar as food. The workers thus gather food for all the members of its bee hive. Some of the workers keep the hive clean. They remove the dead bees and dirt from the hive. They keep the bee hive clean.



7.18. The lac insect. A a twig encrusted with lac ; B, the adult insect

Some other workers keep a constant watch of the bee hive. Some foreign insects enter into the hive to get honey. The worker bees either remove their wings and throw them out or sting them to death.

Since thousands of bees live in a bee hive, it needs a supply of fresh air. Some of the workers bring fresh air into the hive by constantly working back and forth their wings. Some workers remain inside and keep the air moving inside the hive.

If you closely examine a bee hive, you will find that the chambers are made of wax. The wax is secreted from the body of worker bees. The worker bees scrape the wax from their bodies and build the chambers. In these chambers their food, namely, the pollen and honey are stored. The young bees are hatched in some of the chambers.

The worker bees take care of the queen and drones of the hive. Thus the worker bees do different kinds of work. They collect food, keep the hive clean, guard the hive from enemies, supply fresh air and make wax chambers. All this work is divided amongst the worker bees in a beehive.

The Drones : The drones have short tongues. Therefore they cannot gather nectar from flowers. They cannot gather pollen since they have no pollen baskets. The workers feed the drones with food. The only task the drones do is to fertilize the eggs of the queen. After they complete this work, they are killed and thrown out by the worker bees.

The Queen . In every hive there is a single permanent queen bee. The work of the queen is to lay eggs. She goes on laying eggs all through her life. The queen bee is thus the mother of all other bees in a hive.

The queen bee lays one egg in each chamber. The eggs hatch and small worms come out. These worms are fed by the worker bees. After some time the worms change into honey bees. If another queen bee is produced inside a hive, both cannot live in the same hive. One queen must go out. The younger one goes out along with some workers and drones and starts a new hive.

SUMMARY

Insects are arthropods with three pairs of legs. Many insects possess one or two pairs of wings. The body of an insect is divided into head, thorax and abdomen. By studying the structure of a cockroach one can understand the general body plan of an insect. Insects are adapted for living different modes of life. Butterflies, grasshoppers, praying mantis, stick insects, leaf insects, crickets, dragon flies and wasps are some of the common insects with interesting ways of life.

Insects lay eggs. The young ones that come out of the eggs are often very much different from the adult ones. They undergo a series of changes before they become adults. Such a change is termed metamorphosis.

Some insects are harmful to us. They may act as carriers of certain disease causing germs. Many insects cause considerable damage to our agricultural food products.

Man is constantly fighting against harmful insects to bring them under control. But some insects like honey bees, silk worms and lac insects, provide us useful products. Insects help in pollinating flowers of plants.

Some insects like honey bees, termites and ants live as colonies. Such insects are called social insects. There is a division of labour among social insects. For this purpose different "castes" of insects live in the same colony. They all work for the common good of the colony.

Questions

1. How will you find out that an animal picked up by you is an insect?
2. (*a*) What are the respiratory organs in an insect?
   (*b*) How does an insect differ from an earthworm in its respiration.
3. (*a*) What do you understand by the term "Metamorphosis".
   (*b*) Describe with the help of neat sketches the metamorphosis of any insect you have studied.
4. How does a mosquito carry disease causing germs. In what way, the carrying of disease by mosquitoes is different from the one adopted by the house flies?

5. What are the diseases carried by the following insects (*a*) Flea (*b*) Culex mosquito (*c*) *Anopheles* mosquito
6. Give a short account of some of the beneficial insects.
7. In what ways do the insect pests cause harm to our useful plants?
8. (*a*) What is meant by insect control?
   (*b*) How is control of insects different from eradication of insects?
   (*c*) Name some insecticides that are useful for killing insects.
9. (*a*) What is meant by the term biological control?
   (*b*) How can the insects be biologically controlled?
10. (*a*) What are social insects?
   (*b*) What are the various works performed by worker bees in a beehive?

Tasks

1. Dissection of a cockroach and identification of the various internal organs organized into systems.
2. Observation of the life of insects in nature.
3. Collection and preservation of the most common insects of the locality.
4. Rearing of caterpillars to study metamorphosis.
5. Collection and exhibition of the useful products of insects.
6. Visit to a nearby farm to observe the damages caused to crops by insect pests.
7. Collection, preservation and exhibition of the harmful insects and the damage caused by them to useful plants.
8. Examination of the different castes of honey bees.
9. Observation of pollination of plants by insects.
10. Observation of the habits of house fly, mosquitoes, and fleas.

Spiders are quite common in the gardens and in houses. Some spiders look frightful and many children are afraid of them. All spider are not harmful. Some spiders help us by eating other insect pests as grasshoppers and plant lice which do harm to our plants.

What are these spiders ? Spiders, scorpions, ticks and mites are the members of the group *Arachnida.* All arachnids have jointed legs and form a part of Arthropoda. To a common man the spiders outwardly resemble the insects. But there are a number of differences in which arachnids differ from insects and other arthropods. Count and see the number of legs in a spider. There are four pairs of legs. Insects have only three pairs of legs. You have seen that in crustaceans and insects there are compound eyes. Arachnids have simple eyes. In arachnids the body is divided into cephalothorax

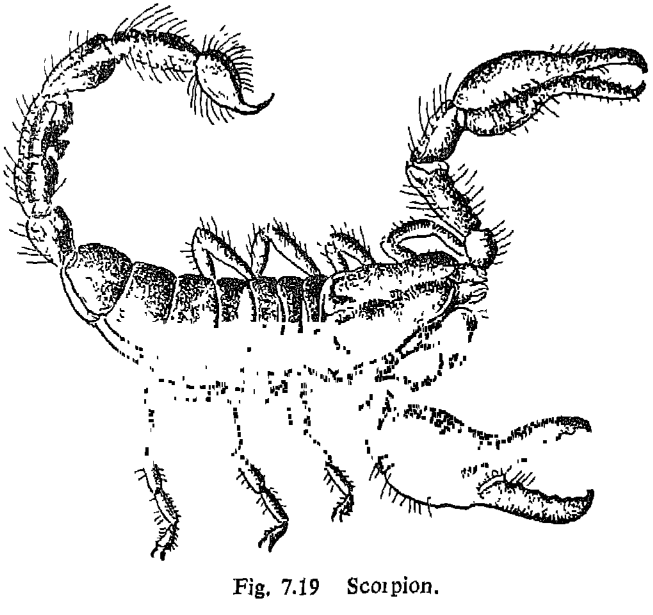


Fig. 7.19 Scorpion.

and abdomen. In insects the body is divided into a head, thorax and abdomen. Arachnids have no antenna. Antenna are found in crustaceans and insects.

Scorpion

Let us take a close view of the body of a scorpion which is a member of Arachnida. The body of scorpion is divided into eight segments. There is a pair of large claws in the front. The scorpion seizes and holds its prey with these claws. The narrow part is its tail and this has five segments. The tip of the tail has a sting. The sting has two small openings. These openings are connected inside to the poison gland. There are two or three pairs of small eyes. Stigmata are seen at the sides of the body.

Scorpions spend the day time under loose stones, barks of trees or burrows. In houses they may remain concealed in any protected place. They become active at night. Animals that become active during nights are called nocturnal animals. Scorpions keep their tails arched over their body in a peculiar way. Scorpions feed largely on insects and spiders. They capture their prey with their claws and kill them with their sting. Female scorpions give birth to young ones. These young ones are carried on the back of their mothers for sometime.

The sting of the scorpion is painful and the stung parts of the body usually swells and becomes reddish in colour. The sting is not very dangerous to human beings. Sometimes, children are reported to have died of scorpion sting. Scorpions do not ordinarily attack man, but will sting quickly if disturbed.

Spider

The body of the spider is divided into two parts. It has four pairs of legs. Each leg of a spider ends in a claw. These claws help the spider to cling to their webs. Spiders have large number of hairs on their body. These hairs help them to feel their surroundings. You have studied that the antenna of cockroach enables it feel nearby objects. Since spiders have no antennae, the hairs act as the feelers. Spiders have normally eight small simple eyes. With all its eight eyes it is unable to see objects from a distance. Many spiders are near-sighted.

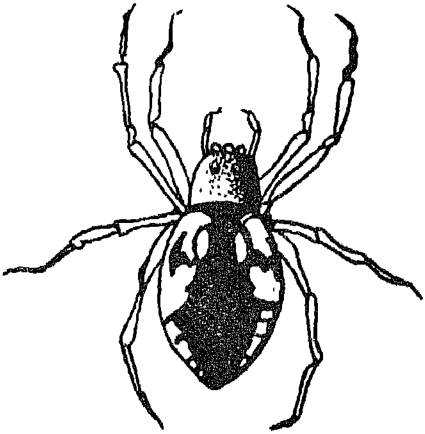


Fig. 7.20. Spider.

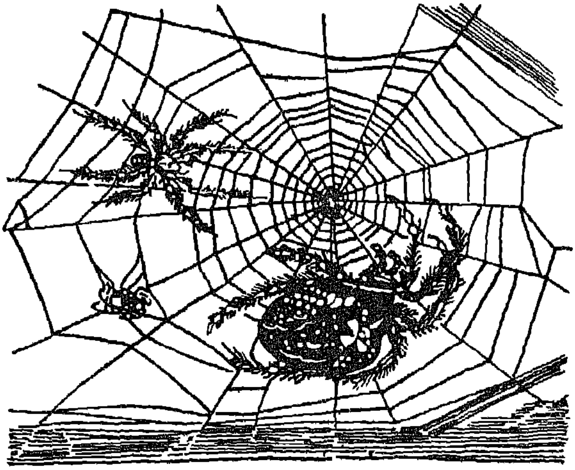


Fig. 7.21. Spider web : Orb Web.

Do you remember the jaws you have seen in insects like grasshoppers ? Spiders have no such jaws. Therefore, they cannot chew their food. The mouth of a spider is small and on either side of it there are two sharp fangs. These fangs are connected to poison glands. Poison from these glands come out through the openings of these fangs. At the sides of the mouth, they have a pair of small leg-like part called feeler legs or pedipalps.

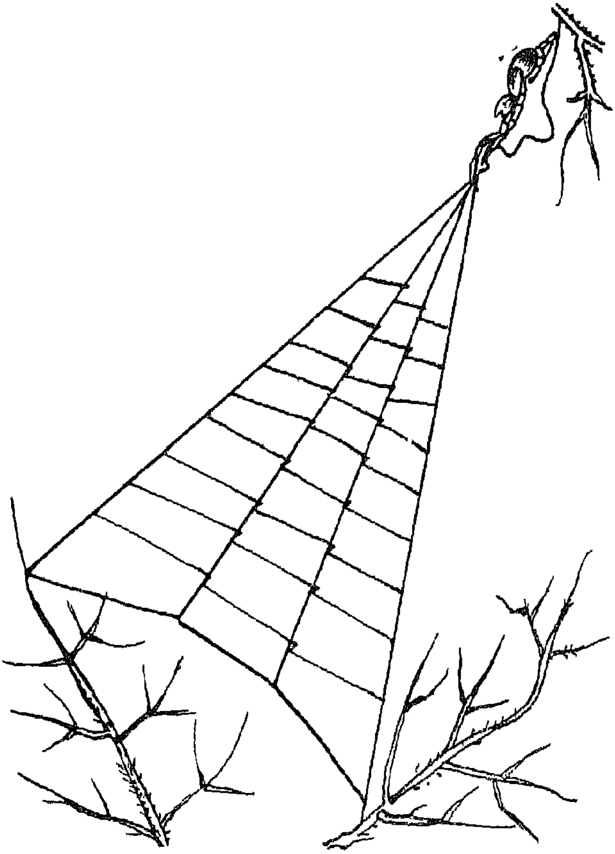


Fig. 7.22. Spider web · Triangular Web

The interesting organs of a spider are its *spinnerts*. The spinnerts are tiny tubes or plates situated near the tip of the abdomen. They help in spinning the silk thread.

Spider's Web

Webs of spiders are common to you. They are found in many places like gardens, houses, fields, and forests. The silk that is used in making the web is produced inside the body of the spider as liquid. It flows through the openings of the spinnerts. The liquid flowing out gets hardened into silk when it comes in contact with air.

Most spiders make webs. There are some spiders that cannot make webs at all. Different kinds of spiders make different kinds of webs. The most common web which you see quite often in the gardens is the orb-web. An orb-web is circular like a wheel. When you go to your garden or when you visit a park next time, look out for an orb-web. Carefully observe the nature of the web. There are a number of spokes in a web. Strands of silk are wound connecting the spokes. Different kinds of spiders put in different numbers of spokes in their webs.

It is really interesting to watch a spider build its orb-web. Next time if you get a chance observe how a spider spins a web.

In addition to the orb-web there are other kinds of webs. You can see many varieties webs in your own garden or in the fields and forests. The webs that are triangular in outline are called *triangular Webs.* Some spiders that live in bushy grasses build funnel shaped webs. Sometimes you might find dome-shaped webs among the leaves of hedge plants. Certain spiders build their webs in an irregular way without any shape.

Food and food capture

The webs are useful to the spiders to catch their prey. Animals like insects get caught in a spider's web. As soon as a spider finds its prey in its web, it comes near it and completely covers it with its silk. The prey cannot escape. The spider makes the puncture in the body of its prey and sucks the juice.

Thus spiders suck only juices of living animals. The insects are the most common food of spiders. The best way to see how a spider eats its food is to drop a living insect in a spider's web and to observe it. Sometimes you might not find spider in the web. You should not alway think that the spider has deserted its web and gone away. Certain spiders leave the web but keep hiding among the leaves of the plant. It always keeps in touch with the web through one long thread. As soon as a prey is caught in its web, the spider comes to know it by the shake of the web. Then it comes to trap its prey.

How do spiders that build no webs catch their prey? Sometimes you might have seen inside you house a spider jumping on flies and catching them. It is a *jumping spider.* These do not build web.

Tarantula is a big spider growing to a very large size. (5 cm long). It does not spin webs. It hides in the crevices of trees or logs and stones. At night it comes out to hunt its food. *Tarantula* is said to hunt and kill even small birds.

Fig. 7 23. Tarantula.

Ticks : Sometimes you might have seen small roundish animals hidden among the hairs and on the body of dogs. These are the ticks. Ticks are small arachnids. Ticks live on the body of many other animals and man. The body of a tick is not divided into head, thorax and abdomen. A small part attached in front to the body carries the mouth parts. The mouth parts are adapted for biting or piercing and sucking. There are four pairs of legs at the sides of its body.

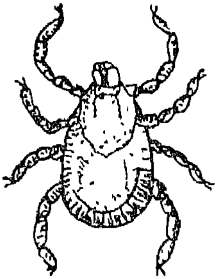


Fig. 7.24. Tick

Ticks live on the blood of the host animals. If their hosts suffer from certain diseases, the ticks suck this blood containing the disease causing germs. When they attack a new normal host, the germs are transmitted to the new host. Thus the ticks act as carriers of disease causing germs. Some diseases of man and a number of diseases of cattle are caused by ticks.

Mites

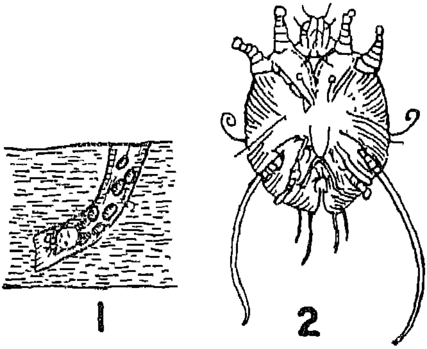


Fig. 7 25. Human itch mite;
1. Female depositing eggs in tunnel in human skin.
2. Adult male (Ventral view).

Mites are minute arachnids. They live in soil, stored food, on plants and in water. Some mites live as plant and animal parasites. The itch mite causes itch in man. The mite feeds on the skin and blood of human being. They lay eggs under the skin. The young ones hatch out and spread the itch. Contact with the persons suffering from the itch helps the *mites* to spread the disease.

Common features of arthropoda

The members of the group Arthropoda have a body that is divided into segments. In some forms the segments are clearly seen, but in others they are not so clear. The segments of the body are often grouped into two or three distinct regions. The body of the animal is covered with a protective shield. This is made up of a substance called chitin. This covering issued and renewed many times as the animal grows. The most important characteristic of all arthropods is the presence of jointed legs. Arthropoda means joint-footed animals.

The body of an arthropod is more complex than that of a worm. This complex nature is seen both in its external features and internal organs.

§ SUMMARY

Arachnids are arthropods with four pairs of legs. The body is divided into a ceptalothorax and abdomen. Antenna are absent. Spiders, scorpions, ticks and mites are different forms of arachnids.

Spiders are of many kinds. Many spiders build webs. These are all built for catching the food of the spider. Some spiders do not build webs, they hunt and kill their prey. Spiders live on the body juice of animals.

Ticks and mites are small arachnids. Ticks live as parasites on the body of animals and suck their blood. Ticks transmit some diseases of man and domestic animals. Mites are microscopic arachnids. Itch mite causes itch in man.

Questions

(1) Do you consider a spider a gardener's friend or foe ? why do you consider so ?

(2) How is a spider different from an insect ?

(3) Give a short account of the spider's web and write how it is useful to it.

Task

1. Observe a spider's web when it is built.

2. Observe how spiders obtain their food.

3. Collect the locally available arachnids and preserve them.

4. Observe and collect the ticks occurring on domestic animals.

CHAPTER VIII

Fish

Fishes are an interesting group of animals adopted for living in water. Two broad groups of fishes are commonly recognized. One group of fishes have bony skeletons. This group of fishes are bony fishes. Mullet is an example of a fish belonging to this group. The other group of fishes are the cartilaginous fishes. Cartilaginous fishes have skeletons made of cartilage. Sharks and rays are examples of this group of fishes.

§ 1. MULLET · A BONY FISH

Mullets are commonly found in seas, estuaries and also in fresh waters. The body is oblong and the head is flat. The colour of the body is grey above and silvery at the sides. The body has a stream lined shape. Streamlined body is one in which both ends taper and the sides are smooth. The streamlined body enables a fish to swim rapidly in water. The body is covered with scales which overlap one another. The mouth is at the front end of the head. There are two nostrils one on

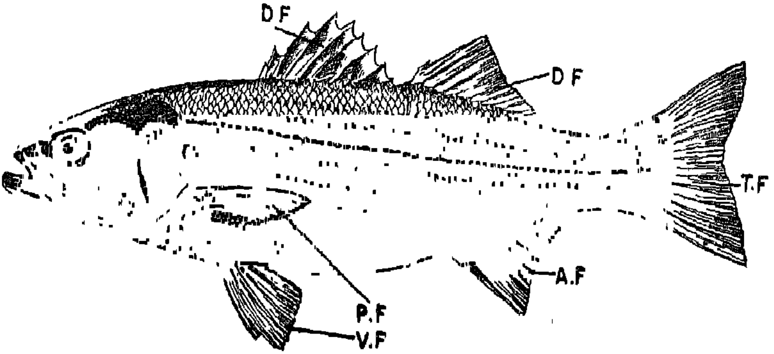


Fig. 8.1 Mullet : External features of the fish D. F. Dorsal fish ; V. F- Ventral fin ; A. F. Anal fin , T. F. Tailfin ; P. F. Pectoral fin.

either side above the mouth. The eyes are without eye lids. Open its mouth and see whether there are any teeth. You will not find any. Pass a pencil through the sides of the mouth of a fish. Do you find it coming out through the opening at the side of the head ? These openings are known as gill-slits. There are two gill-slits, one on either side. The opening is actually covered by a part of the head. This covering is the operculum. Lift the operculum and examine the parts inside. There are certain red coloured structures. These are the gills. Count and find out how many pairs of gills are there in a mullet.

A mullet has many fins. Some of these fins occur as pairs. Different names are given to the fins. Paired fins situated at the sides of the body behind the operculum are known as the pectoral fins. A pair of fins, at the undersurface of the body are called pelvic fins. The fins at the back of the body are the dorsal fins. The fin of the tail is its tail fin. The fin situated slightly behind the anus is its anal fin (Fig. 8.1). The fins show a great deal of variation in different fishes.

Internal organs

You have studied some one celled animals and a few many celled animals like *Hydra,* worms, insects and others. Fishes are also many-celled animals. There is one very important difference between the animals you have so far studied and which you are going to study in this and subsequent chapters. None of the animals you have studied so far has backbones. Fishes and other animals you are going to study have inside their body a column made up of bones. This column is known as the vertebral column. All animals possessing a vertebral column are known as vertebrates or animals with back-bones. One celled animals, *Hydra*, worms and insects have no back-bones inside their body. They are called animals without back-bones or invertebrates.

The vertebral column of a fish is situated in the upper part of its body. It encloses inside a nerve cord as the spinal cord.

The spinal cord is continued in front as the brain. The brain is enclosed in a body case known as the cranium. Do you find any difference between the location of the nerve cord in invertebrates and in fish ? Invertebrates have the nerve cord in the ventral part of their body. Vertebrates have the nerve cord in the dorsal part of their body.

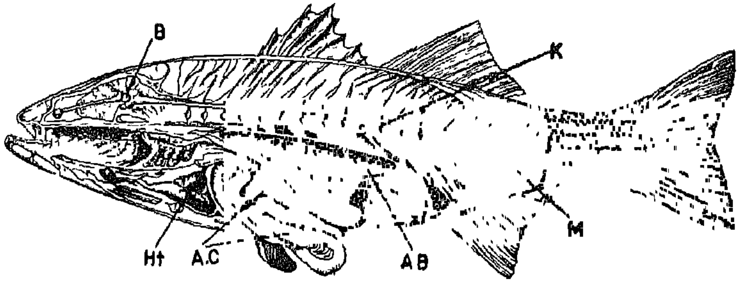


Fig. 8.2. Mullet . internal organs · B. Brain , K. Kidney; M. Muscles; A.B. Air bladder ; A.C. Alimentary canal , Ht. Heart.

A fish, like other animals, has a number of organs which form organ systems. You can see some of these organs in a fish by removing its body wall.

The food canal is prominently seen. It consists of many parts. Pull out the lips of the fish with a forceps. It can be drawn out as a tubular part. Do you know that this tube-like part helps the fish to obtain its food materials ? The mullet fish generally feeds on fine sediments settled at the bottom of rivers and ponds. The mouth tube is helpful to the fish as a shovel in taking its food items. The food particles enter the mouth cavity along with some water. A fish does not drink all the water that enters its mouth along with food. The water escapes through the openings between the gills. The food particles are carried down into the stomach. The stomach is prominently seen as a muscular organ. The food is stored in it and partly digested. A bunch of finger-like tubes capped over the stomach help in sending digestive juice into the stomach. This juice digests the food. The long coiled tubular part of the food canal is the intestine. The food is digested and the waste products are sent out through the anus.

A dark brown structure is seen attached to the food canal. This is the liver. The greenish spherical body embedded in the liver lobes is the gall bladder. A small dark red body known as spleen is also seen near the liver.

On displacing the food canal a pair of kidneys can be seen. The kidneys are the organs that excrete waste products. The male mullet has a pair of whitish organs inside its body. These are known as testes (singular-*testis*). Sperms are produced inside the testes. The female mullets do not have testes. They have yellow-coloured bodies known as ovaries. The ovaries produce a large number of ova or eggs.

These ova or eggs are shed into the water. The sperms are also discharged into the water. A sperm gets into an egg and fertilizes it. The fertilized egg develops into a larval fish. This ultimately grows into an adult fish. The fertilization and development of the eggs take place in water. The parent mullets do not care for their young ones.

Below the kidneys and extending along the body cavity is a thin-walled sac. This is known as the air bladder or swim bladder. When it is filled with gas the body becomes lighter and the fish can rise up to the surface. On the other hand when the gas is compressed in the bladder, the body becomes heavier and sinks in the water.

§ 2. DIFFERENT KINDS OF FISHES

All fishes have certain common features. They live in water and move with the help of fins. They possess gills for breathing. The exchanges of gasses take place in the blood vessels of the gills. In spite of these common features, fishes differ from one another in many features. Most fishes have scales on their body whereas certain fishes have no scales. The nature of the scales might also differ in fishes. The fishes differ in sizes. Some fishes are only a few centimetres long. There are fishes that are very long. We cannot appreciate the true colours of fishes unless we see thems in their living conditions or immediately after they are caught. The colours fade away quickly after the fishes are dead. Fishes differ in their body shapes and in the number and shapes of their fins. Can you imagine that more than 20000 kinds of fishes are known to scientists ? Who knows there might be many more in the seas, rivers, lakes and reservoirs, that are not known to man.

Shark

You might have seen a shark. Sharks are of many kinds. They live in seas. All sharks have cartilage in their body. They have a peculiar kind of minute scales covering their body. If you touch the body of a shark, you will feel as if you are touching a sand paper. The rough surface of the body of the sharks is due to the presence of the scales. Some sharks are small, but many are large. Almost all sharks have powerful teeth. They attack fishes and other animals and eat them. Sometimes swimmers, divers and fishermen are attacked by sharks.

Ray-fish

These are related to sharks in having cartilage inside their body. But ray-fishes are flat and have their mouth on the undersurfaces of their bodies Some rays have long whip-like tails. Many ray fishes lie down at the bottom of the coasts buried in sand. Some rays have spines in their tails with which they sting man and other animals. Ray fishes live in seas.

Eels

Eels have smooth, very long scaleless bodies. They resemble snakes in general appearance but are not snakes. Eels respire through gills ; snakes respire through lungs. Eels have fins, but snakes do not have fins. Eels are of many kinds. Some are found in rivers and some in fresh water. Some eels are known to live in fresh water but go to the seas for laying eggs. The young ones hatch out in the sea and grow for sometime there. They return to fresh water and become adults. Such a kind of periodical movement to another place and return to the original place is known as migration.

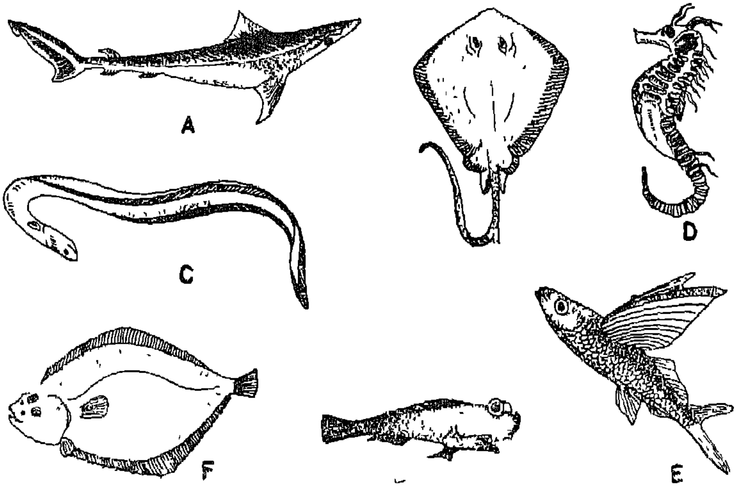


Fig. 8 3. Some types of fishes ; A. Shark , B. Rayfish ; C. Eel , D. Sea horse ; E. Flying fish ; F. Flat fish ; G. Mud skipper.

Sea-horse

The sea horse is an interesting fish. On seeing a sea horse, you may not believe that it is a fish. If you see carefully, you will find the gills and fins. It is called sea horse, because its head and neck appear like that of a horse. A sea horse cannot move fast. Do you see its prominent belly projecting forward. The female sea horse places its eggs inside a pouch on the belly of a male sea horse. The eggs are carried by the male till the young ones hatch out from it.

Flying fish

Flying fish live in the sea. They have well developed pectoral fins. The fish very often comes out of water, spreads its pectoral fins and glides in the air above the surface of the water for a short distance and then gets into the water.

Flat fish

As the name indicates, the body is very much flattened. It lives at the bottom of the seas. It has both eyes on one side of the head. The colour of the upper side of the fish resembles the sea bottom. Therefore it is difficult for its enemies to find it out easily.

Mud skipper

The mud skipper lives in shallow brackish, coastal waters. It very often comes out of water and moves about on the muddy regions of the shore in search of insects. It uses its well-developed pectoral fins as limbs while moving on land. It has no lungs but it can stay out of water for a long time. It has spongy sacs near its gills. The spongy sacs store water in them and keep the gills wet and permit the normal underwater respiration to continue on land.

Sword fish

The snout of this fish is produced into a pointed sword-like projection and hence the name sword fish. It lives in oceans or seas far away from the coast. It is a fast swimmer. It feeds on other fishes. It very often takes a high leap into the air. It is said that it can attack a boat and make a hole in it with its sword-like snout.

Climbing perch

It lives in fresh water ponds. It can live out of water for some time. For carrying on respiration outside water, it has certain additional organs called accessory respiratory organs which can take atmospheric oxygen. It is said that the fish can climb up trees making use of the spines of the ventral fins. When the pond in which it is living gets dried up, it moves on land with its fins and gets into a nearby pond.

Siamese fighting fish

The Siamese fighting fish is a small aquarium fish. The male and females are different in appearance. The male fish is very aggressive. When a male fish meets or even sees its own image in a mirror it spreads its fins and gets ready to fight.

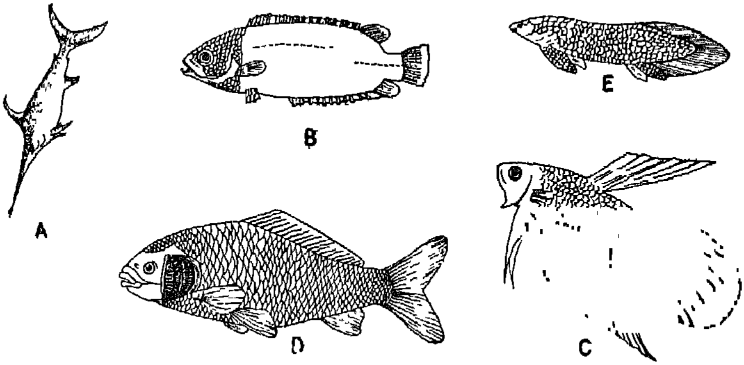


Fig. 8.4. Some more types of fishes A. Sword fish ; B Climbing perch , C. Siamese fighting fish; D. Gold fish , E. Lung fish

Gold fish

This is a beautiful aquarium fish. There are several kinds of them. The name gold fish is due to the golden yellow colour of its body.

Lung fish

Lung fish posses lungs in addition to gills. They come very often to the surface to take in atmospheric air. They live in rivers of certain foreign countries like Australia and Africa. When the river dries up, they burrow deep into the mud and respire with the help of lungs.

Locomotion in fishes

You have seen that the body of a fish is streamlined. The streamlining facilitates easy movement in water. A fish actually moves in water with the bending of its body and movements of its fins.

To understand the body movement of a fish, observe a fish in an aquarium from above. The front part of the body of a fish curves in one direction and the tail part curves in the opposite direction. By alternately bending its front and tail parts quickly a fish produces jerks in water. A series of such jerks acting on the water, causes the body of fish to move forward.

What role do the fins play in the locomotion ? You can conveniently watch the movements of the fins of a fish from the broad side of the aquarium. Some parts of the body of a fish are heavy but some parts are light. For example, the upper part of the head of the fish is heavy. That is the reason why a dead fish floats with its head down in the water and its ventral side up. When a fish is in water, the body must be prevented from toppling and kept upright in position. The dorsal, the pelvic and anal fins help the fish to keep its body balanced. They also help in keeping a straight course while swimming.

What role do the pectoral fins play in the locomotion of a fish ? Observe the position of the pectoral fins in a fish that is moving fast in water. You may find the fins folded along its body. Does it indicate that they are not useful when a fish swims fast ? Observe the fish when it suddenly halts. Note the position of the pectoral fins. Do you find them spread out ? The pectoral fins help as breaks in holding a fast moving fish. They also play certain other roles. You will understand these, if you watch a fish that is either slowly moving or just balancing in water. You might have seen the way the oars are worked to move a boat. The pectoral fins work like oars and help the fish in its slow movement. The pectoral fins are also used in balancing the body and in turning it when slowly swimming.

The tail fin can be compared to the rudder or a boat. The rudder of a boat is used to change the direction of its movements. Closely watch the movements of the tail fin when a fish is moving. When the tail fin turns to the right the body turns to the left, thus the tail fin is useful in steering the body of a fish while swimming.

§ 3. FISH FAUNA IN SEA, FRESH WATER AND ESTUARIES

Fishes are found in seas, rivers, reservoirs, ponds, tanks and wells. Fishes also live in estuaries. An estuary is that region where the fresh water of a river mixes with salt water of sea. Fishes that live in seas do not normally occur in fresh water. Some marine fishes are sharks, rays, sword fishes, flat fishes, mackerels and sardines. Likewise, fishes that live in fresh water do not occur in the seas. For example, various kinds of fishes called carps are found only in fresh water. Certain fishes that are most commonly found in ponds and tanks are very rarely found in rivers. What do you understand from these ? Though all fishes live in water, a particular kind of fish may be suited for living in a particular type of water. Sea water, for example, is salty. Only those fishes that can tolerate salt water can live in it. These fishes are said to be adapted for living in the sea. If these sea fishes are transferred to fresh water, they die since they are not adapted for living in fresh water.

The water in an estuary is salty, but it is less salty than sea water. Some fishes that live in the sea, find it possible to live in estuaries. Some fishes that normally live in rivers can also live in estuaries. Mullets are a group of fishes that are found in seas, rivers and estuaries. Hilsa or the Indian shad that lives in seas ascends up estuaries during certain seasons. Fishes like mullets can tolerate a wide range of salt content in water. Thus the fishes that live in estuaries are a mixed group in fishes some of which live in rivers and some in seas.

The flow of water is very fast in certain rivers and streams. Only those fishes that have strongly built body and strong fins can successfully live in fast flowing waters. Some fishes feed on the living things—found in the surface layers of waters, whereas certain other fishes feed on the materials deposited at the bottom. Thus the fishes get themselves distributed in waters according to their habits and their capacity to live in a particular type of water.

Why is man interested in finding out the ways of life of fishes ? The knowledge he gains about fishes enables him to devise means for effectively catching fishes. Fishes form a good source of highly nutritive food for many people.

Food Chain

You have learnt in the earlier lessons that green plants are the only living things that are capable of synthesizing food materials out of certain simple substances like water and

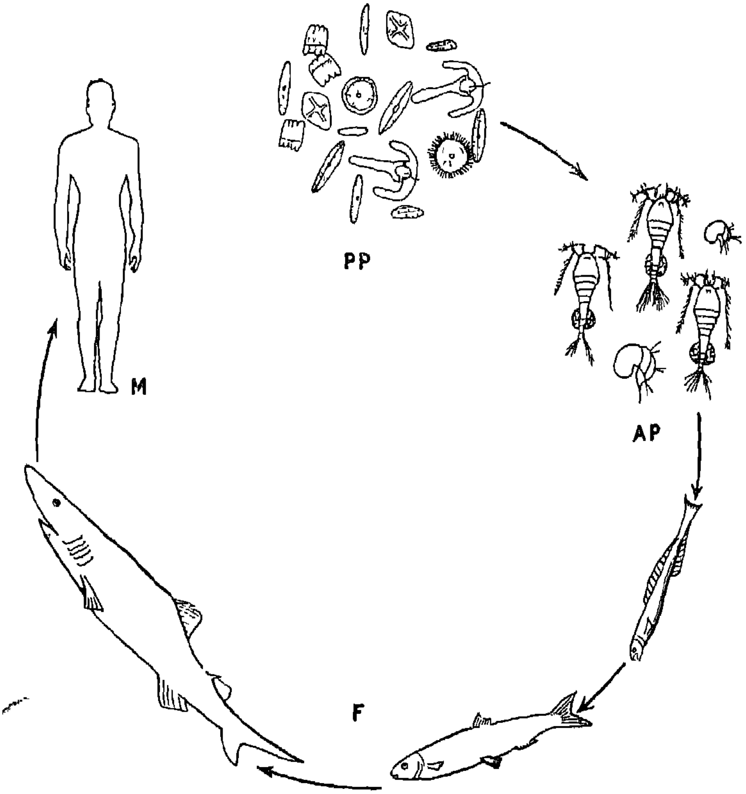


Fig. 8.5. A food chain : P.P. Plant plankton; A.P. Animal plankton ; F. Different sizes of fishes , M. Man.

carbon dioxide in the presence of sun light. All animals including man are dependent either directly or indirectly upon the green plants for their food. This dependance is true not only on land, but also in water. In water there are various kinds of plants. Many animals depend upon these plants for their food. The most interesting and important among these plants are diatoms.

Diatoms are minute one-celled plants that can be seen well with the help of microscopes. They float on the surface of water. They are of many kinds ; some of them are found in fresh water and some in the seas. They possess chlorophyll and can therefore manufacture food materials.

The diatoms form an important item of food for small crustaceans like copepods. The copepods and other similar crustaceans are eaten by young fishes. These young fishes are eaten by larger fishes, and these fishes are eaten by still larger fishes. Some big fishes directly take the water containing the diatoms and crustaceans. These minute organisms are filtered out in the mouth cavity and swallowed as food by the fishes. Thus there is a chain of feeding. Since the chain of feeding pertain to the food, this is called a food chain.

If there is any disturbance for one organism constituting the food chain, the organisms that depend upon these are affected. For example, if suddenly all the diatoms disappear from the sea and fresh water, the fishes that are directly and indirectly dependant upon the diatoms will starve and die. The whole balance of nature in water will be disturbed. The fishes which form the food of some people are dependant wholly upon life in water.

Food value of fish

We take different kinds of things as our food. Do you know why ? You might say that different things give you different tastes and smell. Apart from this, food materials provide energy to our body to do work ; they help our body to grow ; they keep us free from certain diseases ; they help us to have strong bones and teeth. For all these, different kinds of *food substances* are required by our body. These food substances are present in different proportions in different food materials.

The energy needed by our body is provided by carbohydrates and fats. Carbohydrates are present in wheat, rice, maize and sugar. Fats are found in oils, ghee, and butter. Proteins which help to build our body occur in pulses, eggs, meat and fish. Vitamins are another kind of substances small quantities of which keep us free from certain diseases. Vitamins are of various kinds. Absence of one kind of vitamin produces a particular kind of disease. Various mineral salts are required by our body. The most important among these are calcium salts and phosphates, which are useful in building strong bones and teeth.

The daily quota of food of many of us ordinarily include a large proportion of wheat or rice products. These are composed mainly of carbohydrates. The food materials consisting of proteins, vitamins and minerals are often taken by us in lesser quantities than that required by our body.

The bodies of fishes are rich in protein. The protein contained in fish is easily digestible. It has been found to be highly useful in producing good growth of animals. Fishes are also very good sources of many vitmains. There is plenty of calcium salts and phosphates in fish.

The growth of human body is not the same at all ages. The growth is more in young people than in the older. Therefore, the rapidly growing body of young people require more of proteins and minerals. To those who can eat fish, it is a very good source of these substances.

§ 4 POPULAR FOOD FISHES

You have learnt that there are more than 20,000 fishes known to science. Not all these fishes become popular as food fishes. Some fishes are not eaten, because they are poisonous to man. Certain other fishes may be very rare or may have small amount of flesh or they may not taste well to man.

Thus, those fishes that are caught in large numbers, harmless to human body and good to taste become popular food fishes. Fishes that have a good amount of flesh, less bones, and good taste are ranked as excellent fishes for the table. The following are some of the good and popular food fishes of our country.

Catla

Catla lives in rivers, reservoirs and ponds. It has a broad body, a single dorsal fin and an upturned mouth. It can grow to very large sizes (1.25 meters in length). It feeds on minute organisms that float in the upper layers of water.

Rohu

Rohu is a freshwater fish. It can be distinguished by its small pointed head, mouth situated at the tip of the head and reddish scales on its body and pinkish fins. It is considered to be a very tasty fish. It also grows to large sizes. It feeds on the matter that has settled at the bottom of rivers and ponds.

Mrigal

It resembles somewhat a Rohu in its general appearance. It is recognized by its small head with a blunt snout and a silvery body with reddish fins. It is also a bottom feeder.

Murrel

Murrel lives in fresh water. It can remain alive out of water for sometime. Its head resembles that of a snake. It has long continuous dorsal and anal fins. It feeds on fishes, insects and frogs.

Indian shad

It is otherwise known as *Hilsa.* It lives in coastal waters and ascends up rivers. It has a compressed belly. The flesh has plently of fat. There are numerous fine bones inside its body. In spite of these bones, it is popular as a food fish because of the very good taste of its flesh.

Shark

The flesh of sharks is rich in protein content. Sharks are relished as food mostly in the coastal areas.

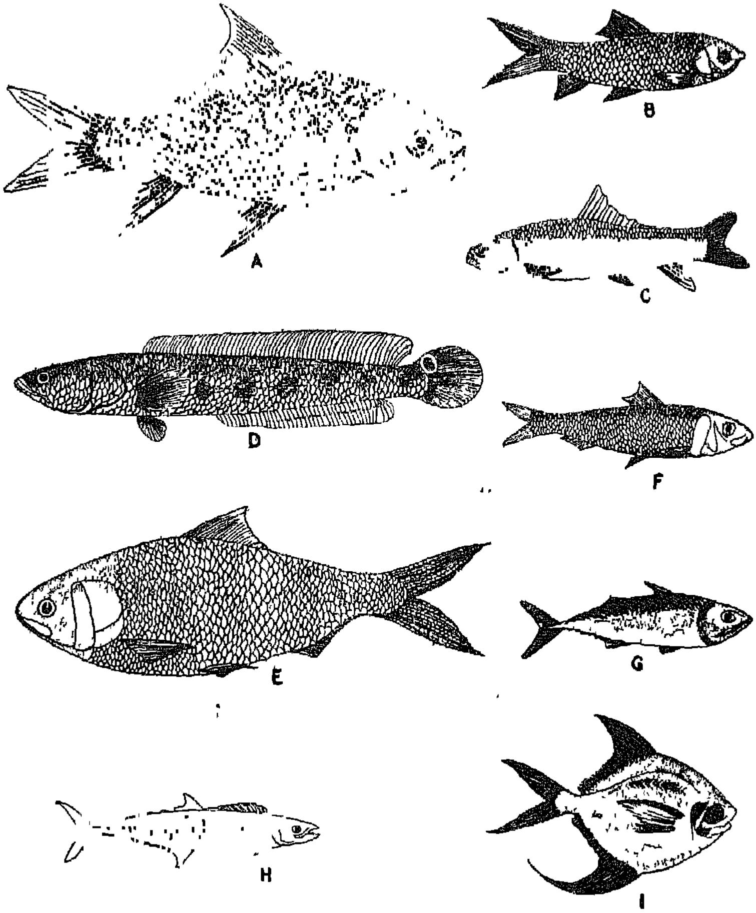


Fig. 8.6. Some food fishes ; A. Catla ; B. Rohu ; C. Mrigal ; D. Murrel ; E Indian shad ; F. Sardine ; G. Mackerel; H. Seer fish ; I. Pomfret.

Oil sardine

It is called oil sardine because of the high content of of oil in its flesh. It is a small sea fish, but caught in enormous quantities in certain seasons in the Malabar and Kanara coasts of India. It feeds on the minute organisms living in the upper layers of waters.

Mackerel

It is also a small sea fish caught in enormous quantities in the west coast of India. It feeds on minute organisms that live in the surface layers of water.

Seer fish

It is a sea fish capable of swimming very fast. It lives on other fishes, squids and cuttle-fishes. The body is mostly without scales excepting certain minute scales in some regions of its body.

Pomfret

Pomfret is a sea fish. Two kinds of pomfrets can be easily made out. One is greyish brown in colour and often called as the black pomfret, and the other is white in colour, called the white pomfret. Pomfrets have soft bones and delicious flesh.

§ 5. FISHING

Fishes are abundantly available in seas, rivers and reservoirs. But they become available to us only when we catch them. The more effective the means of catching, the better are the landings of fishes. The simplest and the most familiar form of catching fishes is by angling. You might have seen some people patiently sitting on the banks of rivers, reservoirs and estuaries with fishing rods. The fishing rod has a long string to which a hook is attached. Bait consisting of either worms or flesh of oysters, or prawns or even flesh of a fish is attached to the hook. A fish swallows the bait along with the hook and thus gets caught. By this method one is not sure of catching fishes on a large scale. Only those fishes that eat worms or the flesh can be caught by the method. But there are fishes that do not feed on worms or flesh. There are fishes in different parts of the seas, rivers and reservoirs. How to catch them ?

For catching large numbers of fishes two things are necessaay. One is a means of getting to different places in water, where fishes are available. This is done with the help of crafts. Crafts are of different kinds. Boats with sails, catamarans, canoes, coracles are some kinds of crafts. The other necessary thing for catching fishes is the fishing gear. The most commonly used fishing gear are the nets. Sometimes traps and lines are also used for catching certain fishes.

Nets

Nets are of various kinds The small nets are generally made of cotton yarn. The large nets are made of hemp or synthetic yarn like nylon. The catch of fishes caught by different kinds of nets vary. The following are some of the types of nets in constant use for fishing.

Stationary net

A stationary net is commonly rectangular. It is fixed dur-

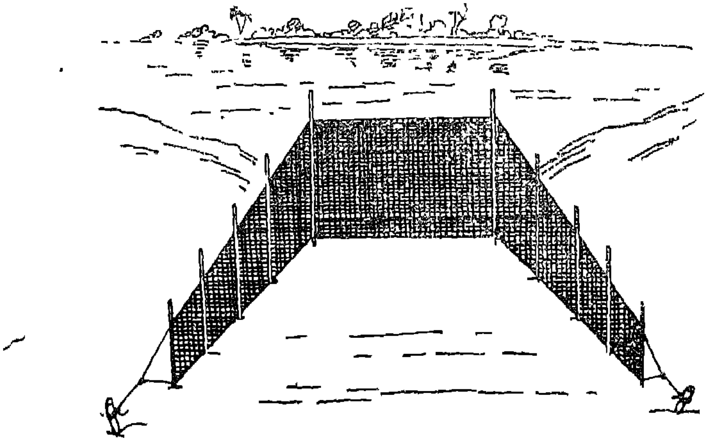


Fig. 8.7. Stationary net.

ing the low tide enclosing a shallow coastal region. The net is kept in position with the help of stakes, floats and sinkers. The high tide brings the fishes in the net. When the tide recedes, the fishes are trapped. The meshes of the net are too small to allow the escape of big fishes. Various kinds of fishes are trapped in this net.

Bag-net

A bag net is conical in shape. It has a wide mouth and a tapering end. The mouth of the net is kept open with weights of stones attached at its lower side and floats attached to its upper part. Sometimes the bag net is towed by two boats by means of stout ropes attached on either side of its mouth. Shoals of fish that enter into the net are thus captured.

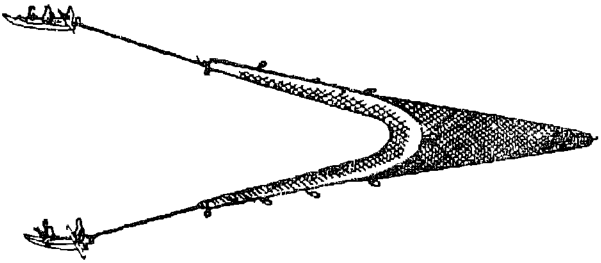


Fig. 8.8, Bag net.

Drag net

A drag net is very long. Wooden floats and stone sinkers

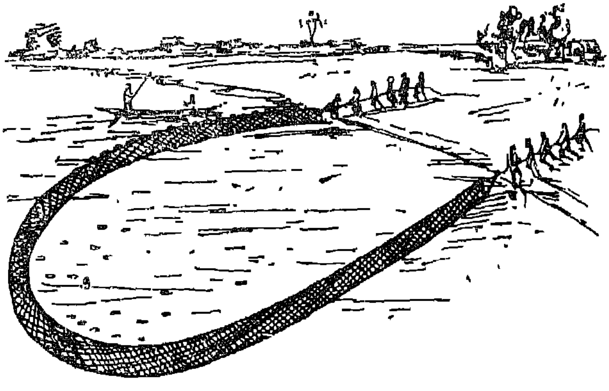


Fig. 8.9. Drag net.

are attached at regular intervals to the upper and lower part of the net respectively to keep it in position. One end of the net is tied to a wooden peg in the shore. A boat carries the net and makes a semi-circle paying out the net. The other end of the net is brought back to the shore. The two ends are drawn by groups of men. Thus the net with the trapped shoals of fishes are brought to the shore.

Gill Nets

A gill net is a wall-like rectangular net of great length. Sinkers are attached to the bottom of the net. Floats are attached to the upper part of the net. The sinkers and floats keep the net in an extended position. Fishes swimming through the net get gilled.

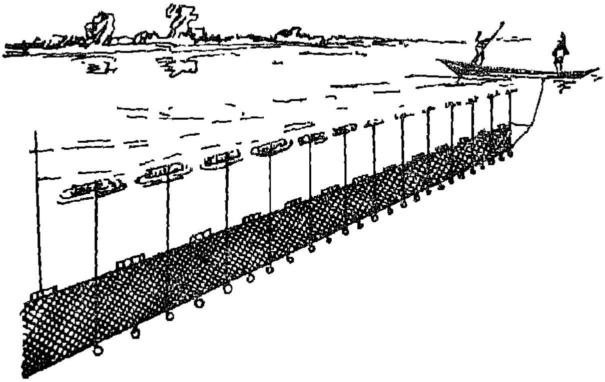


Fig. 8.10. Gill net.

A gill net may be fixed in a particular place or may be allowed to drift. A net that drifts is called a drift net.

Trawl

Trawl net is a big net operated from one or two big mechanized fishing vessels usually in sea far off from the shore. A trawl is really in a huge bag net with winglike extensions from its mouth. Trawl nets operated from port areas bring very good catches.

Lines

Lines with baited hooks are used for catching big sharks.

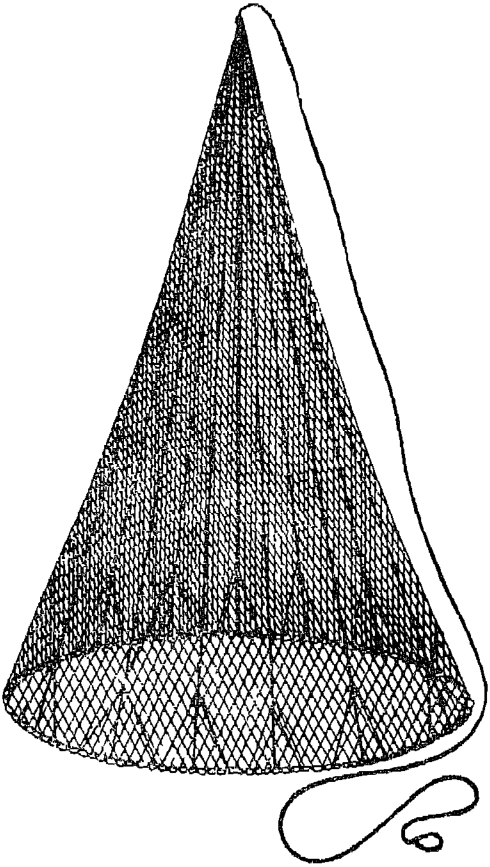


Fig. 8.11. Cast net.

§ 6. FISHING IN SEAS, ESTUARIES, RIVERS AND RESERVOIRS

Fishing in sea

Gill nets, drift nets, bag nets, drag nets, cast nets, trawl nets and lines are used for fishing in seas. Sometimes the same type of net, but with different mesh sizes of mest are used for catching different kinds of fishes. In recent years, nets made of nylon which are much durable are being used for catching fishes.

Fishing in Estuaries

The movements of water due to the tides of the seas is found useful for fishing in estuaries. Different kinds of bag nets and stationary nets are employed against the tidal currents.

Drag nets, cast nets, drift nets are operated for fishing in estuaries. Traps made of bamboo materials are extensively used for fishing.

Fishing in Rivers and Reservoirs

Drag nets and bag nets are very popular for fishing in rivers and reservoirs. Lines, cast nets, drift nets are also operated.

The kind of fishing gear depends upon the nature of the water area and the kinds of fishes that are mainly available in such areas. Most of our fishing gears are traditional and local types. They need to be improved for effectively catching fishes.

Fishing Industry

The average annual fish production in our country is estimated to be about one million tons. Two thirds of this is from the sea and the rest from fresh water. This fish production in India as compared to the production in other countries, is rather low. The annual fish production in certain other countries are given below.

Country	*Annual fish production (in million tons)*	*Country*	*Annual fish production (in million tons)*
Japan	4.7	Norway	2.01
U.S A.	2.9	Canada	1.07
U.S.S.R.	2.6	United Kingdom	1.45
China	2.5	India	1.01

India has large areas of water where fishes are either available in plenty or can be cultured successfully. There is a coastline of about 4,700 km in length. About 2,60,000 sq. km of shallow region of the coast line are abundant with fishes. Vast areas of the Bay of Bengal, Arabian Sea and Indian Ocean have rich fishing grounds. The fish landing from the seas is low because they are not effectively fished. The fishing in seas is confined to the narrow coastal area 11—16 km in width.

The fishermen are not able to reach the grounds rich in fishes with the help of ordinary slow moving sail boats. As some of these fishing grounds are far away from the shores, only fast moving vessels fitted with engines can take the fishermen to these places. Fishing vessels with engines are being introduced in certain parts of India and very good catches of fishes are being obtained.

The total length of all rivers and their main tributaries is 27,360 km. The length of canals and irrigation channels is 1,12,650 km. This with other fresh water areas constitute several million acres of water surface where fresh water fishes can be captured. But at present only about one million acres are under fish culture. By bringing all the available areas of freshwater under fish culture, the fish production can be enormously increased.

SUMMARY

The body of a fish is adapted for living in water. Adaptations are seen in its streamlined body and fins for swimming in water, its gills for respiration.

A fish is a vertebrate animal. The positions of the heart and the nerve cord are just the reverse of what they are in animals without backbones. A vertebrate has a nerve cord on its upper side and the heart in its lower side; in addition it has a column of backbones.

All fishes live in water and are adapted for living in it. Some fishes are adapted for living some time without water taking the atmospheric oxygen.

Fishes have different kinds of fins and these fins are helpful in its locomotion in different ways. The dorsal, pelvic and anal fins help to maintain the stability of the body of the fish while swimming. The tail fins help to change the direction of its movement. The pectoral fins help the fish in its slow movement and for balancing the fish in water.

All fishes are ultimately dependant on the plant life in water. The most significant among the plants from the view point of food of fishes are the diatoms.

Fishes are rich in easily digestible proteins, various vitamins, and mineral salts. Though there are several kinds of fish, only a limited kind of fishes have become popular food fishes.

Fishes are caught with different kinds of gears. The gears and crafts in use are of the traditional type and often local in character.

The fishing industry is underdeveloped in our country. We have a very large coast line which is not properly exploited for the fishery resources available. Large areas of fish growing water still remain unexploited.

Questions

1. (*a*) What is a vertebrate animal? Give some examples.
   (*b*) What are the main body features in which vertebrates differ from an invertebrate?
2. A fish is adapted for living in water. What are the body features in which the adaptations of a fish for aquatic life are well seen?
3. (*a*) What is meant by a food chain?
   (*b*) How are all fishes dependent upon algae for their food?
4. Why are fishes considered to be highly nutritive food?
5. (*a*) Draw a neat diagram of any aquarium fish you have seen and name its fins.
   (*b*) What are the uses of different fins in the locomotion of a fish.

6. You are given some dead fishes. You do not know anything about their habits. How can you find out the nature of the food of these fishes?

Tasks

1. Secure a mullet and observe its external features.
2. Collect different kinds of interesting fishes locally available.
   (*a*) Paint some pictures of fishes.
   (*b*) Prepare interesting accounts of each one them.
   (*c*) Observe the position and movements of the different fins in an aquarium fish while it is swimming.
   (*d*) Draw a neat sketch of the various internal parts of a dissected fish.
   (*e*) Collect and observe the locally available food fishes.
   (*f*) Examine the stomach contents of different kinds of fish to find out their food habits.
   (*g*) Visit a nearby fishing village to find out the different kinds of gears used for catching fishes.
   (*h*) Visit any nearby fishing place and see the operation of a fishing gear and the fish catches.
   (*i*) Observe the diatoms under a microscope.

CHAPTER IX

Amphibians

Have you ever been near a pond on a summer evening? If you had been, you might not have failed to hear a loud croaking noise. Such noise is also heard from the paddy fields. On certain rainy days, the noise becomes very loud. Did you ever try to know the cause of the noise? The noise is produced by frogs. Frogs are amphibians, that is, those that have two phases of lives. The young tadpoles live in water and the adult frogs move on land and in water.

Habitat

If you are near a pond, you may see frogs jumping into the water from the land. Some frogs stay in water most of the time. Such frogs sometimes float about with only their nostrils above the water. Frogs that live in the water usually stay near plants growing in the water. These frogs come out and stay very near the water in search of food. When the frogs find enemies approaching them, they escape by jumping into the water. Frogs never live in the sea. They cannot live in salt water. Frogs generally are not found either in deep ponds or fast moving streams.

Frogs have backbones just as we have. But the frogs are called *cold blooded* animals. Fishes, about which you have already studied and the reptiles about which you will be studying in the next chapter are also cold-blooded animals. Cold-blooded animals are not always cold. They are cold when their surroundings are cold and are warm when their surroundings are warm. Their body temperature does not remain constant. The temperature of the body changes as the temperature of the surrounding changes.

Frogs cannot bear cold. Therefore, in winter, they bury themselves in the soil. They keep their mouth shut. They respire through the skin. They live on the food materials stored in their body. All the other body activities remain suspended. This is called winter sleep or *hibernation*. In summer when the surrounding temperature becomes very hot, the frogs escape from it by lying quietly in deep cool water or burying themselves in the mud at the bottom of the pond. When the surrounding conditions become favourable they start their normal life.

External Features

The colour of the frog is dark green above and yellow or white below. Can you imagine how this difference in colour helps the frog? The upper green colour of frog merges with the green colour of the plants and pond water. Therefore, frogs will not be easily seen by certain birds that feed on them. Some fishes and other animals that live in water also feed on frogs. When such animals look above from underneath the ponds, the upper layers of water will appear yellowish or whitish in colour. The colour of the undersurface of the body of frogs will merge with the background. The enemies of frogs may not easily be able to see them.

Frogs have no scales, fur or feathers on their bodies. Frogs have soft, moist and smooth skin.

The body of a frog consists of a head and trunk and two pairs of limbs. The frog has neither a neck nor a tail The head bears a slit-like mouth which is very wide. There are a pair of large eyes on the upper side of the head. The eyes are brightly coloured. Slightly behind each eye, there is a circular area, the *tympanic membrane*. The tympanic membrane with certain organs connected with it internally forms the ear. In front of each eye, there is a minute opening through which air is taken in and given out during breathing.

The front pair of legs of the frog are short. Each front leg or fore-limb bears four fingers. The hind pair of legs are

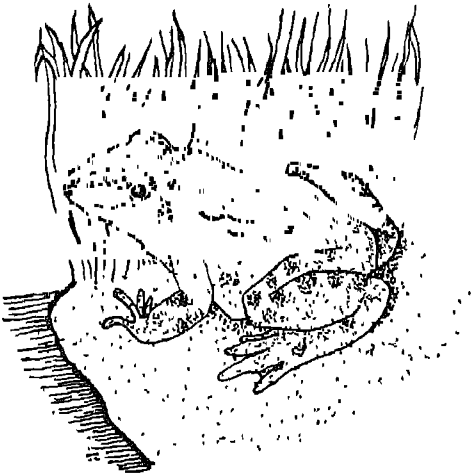


Fig. 9 1. Frog's external features

long and strong. Each hind limb has five toes. A thin membrane, the web, connects the toes.

Locomotion

You have seen that fishes are able to swim in water with the help of their fins. Frogs have no fins. But they are good swimmers. How do they swim in water ? Frogs swim with the help of their hind limbs. The webbed feet push the water backward and this thrust pushes the animal forward. Next time, when you visit a pond, do not forget to observe how a frog swims. Frogs are not strong enough to swim against water that is flowing fast. Frogs caught in water flowing fast are carried away by it.

On land frogs move by jumping. A frog kicks the ground with its hind limbs and this raises and carries the body forward. The short forelimbs are useful to support the body when it falls on the ground. Certain big frogs can jump up to six feet. Many frogs jump twenty times their own length.

Internal Organs

Examine the various internal organs in a frog whose body wall has been cut open. The heart is seen as a pinkish, conical muscular organ. It has three prominent chambers. These are the right and left auricles and the ventricle. Observe the chambers contracting and expanding. The contraction and expansion of the heart is the heart beat. The venous blood is brought to the heart from the various organs of the body through the veins which are bluish red in colour. The

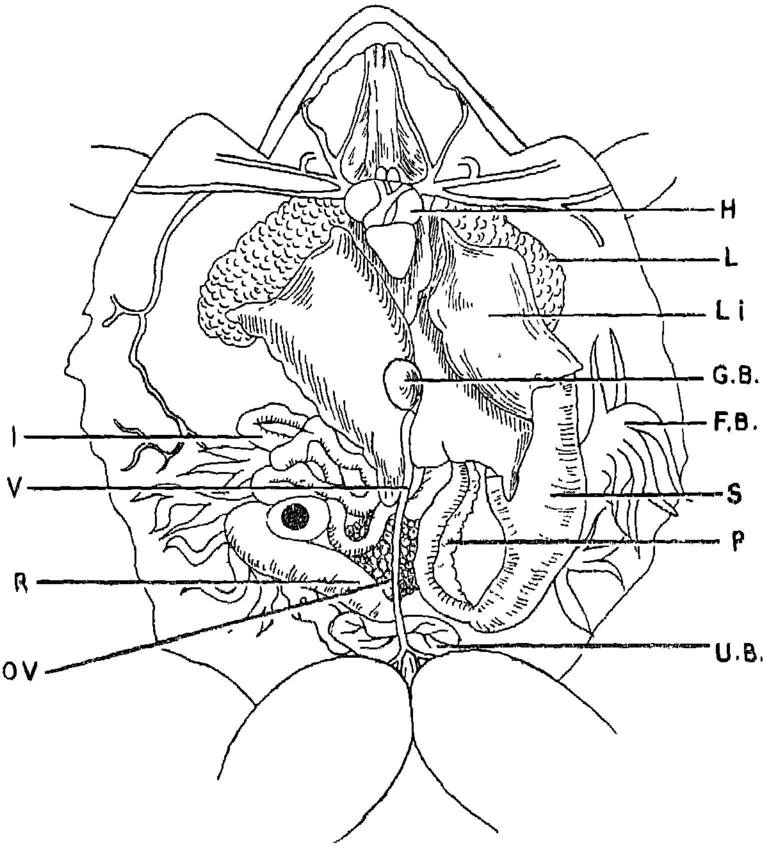


Fig. 9.2. Frogs internal organs H. Heart ; L Lung ; Li Liver ; G.B. Gall bladder , F.B. Fat Bodies ; S Stomach ; P Pancreas , U.B. Urinary bladder ; I. Intestine ; V. Vessel ; R. Rectum, Ov. Ovary

arteries distributing oxygen-carrying blood are seen red in colour.

The frog has a pair of lungs. The lungs are thin-walled sacs. The lungs enclose inside a large number of minute chambers. These chambers are supplied with large numbers of blood vessels.

The alimentary canal consists of a stomach, small intestine and certain other organs. The liver is seen as a brownish organ. On slightly lifting the liver, the gall bladder is seen as a greenish organ. The pancreas opens into the front part of the intestine.

A pair of bean-shaped kidneys are located deeper inside the body cavity. The kidneys help to excrete the waste materials which are eliminated as urine. The urine formed in the kidneys is sent to the bladder through a pair of tubes, the *ureters*.

In addition to these organs the reproductive organs are also present inside the body cavity. A male frog has a pair of testes. Each testis is a yellowish organ attached to a kidney. A female frog has a pair of ovaries. Each ovary is a folded sac containing ova. In addition to the ovaries a pair of white coiled tubes occur in female frogs. These are the oviducts. The ova are sent out of the body through the oviducts.

In both male and female frogs, a cluster of yellowish fingerlike structures are seen. These are the fatbodies. In these bodies fat is stored. The stored fat is used by the animal during its winter sleep.

The brain of frog is enclosed inside the cranium. A number of nerves come out from the brain through certain openings in the skull. These nerves are connected to the different organs of the body. Nerves from the spinal cord come out through holes in the back bone.

Food and feeding

Watch a frog feeding. You would see that it snaps at its food very quickly. Frogs have to be very quick in catching their prey. They may otherwise miss their food.

Frogs feed on animals. They eat mostly insects. They also eat smaller frogs, snails, worms and little fish. Occasionally frogs have been found eating *Calotes*, lizards, snakes, bats and even small birds. Frogs eat animals and things that move. They do not care to eat animals that are either dead or do not move. You can wave a small bit of flesh of any animal in front of a frog and it might catch and eat it.

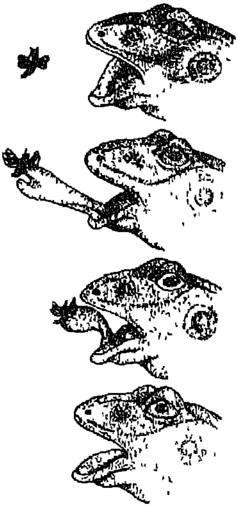


Fig. 9.3. Frog catching an insect

How does a frog catch a flying insect ? It catches it by its tongue. The tongue is fixed in front, but is free behind. It is long and sticky. When the tongue is not in use, it is kept flat in a frog's mouth. As soon as a frog has seen an insect, it shoots out its tongue, and the insect sticks to it. Then the tongue with the insect is folded back and brought into the mouth of the frog. The insect is pushed down from the mouth into the stomach. When a frog swallows its food, you will find it closing its eyes. The closing of eyes helps to push the food down into its stomach.

Frogs swallow their food whole. They do not chew it. They use their minute teeth only in preventing their prey from escaping. A frog catches a large-sized animal by its head and swallows it with its head first.

Respiration

You are already familiar with the lungs of frogs. The lungs are the most important organs of respiration of frogs. But frogs are peculiar in that they have different means of respiring.

Respiration through lungs : During respiration by means of lungs, a frog keeps its mouth closed. The floor of the mouth cavity is lowered. Air rushes inside through the nostrils. After the air has entered into the mouth cavity, the nostril is also closed. Next the floor of the mouth cavity is raised. This compresses the air inside. The air enters the lungs which are connected to the mouth cavity. The walls of the lungs are thin and are supplied with blood vessels. The blood takes up oxygen from the air and gives up carbon dioxide. After this exchange of gases, the walls of the lungs compress and the floor of the mouth cavity is again lowered. Once again, the floor of the mouth cavity is raised and the nostril is opened. The air containing carbon dioxide is expelled. Next time, when you observe a live frog inside your classroom, closely

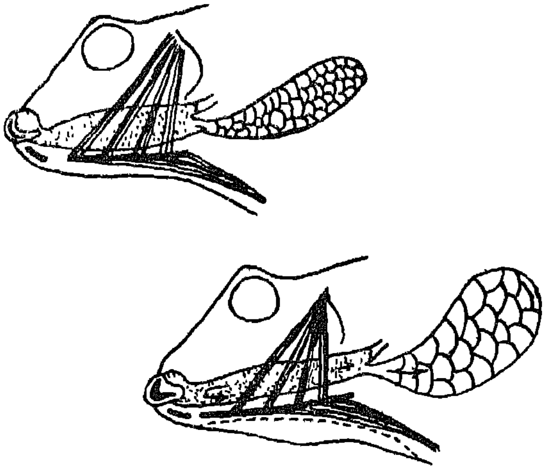


Fig 9.4. Respiration through lungs

observe how the floor of the mouth cavity is raised and lowered at regular intervals.

Respiration through mouth : The inner walls of the mouth cavity are well supplied with blood vessels. Exchange of gases can be brought about in the mouth cavity itself. When a frog is observed at rest, the floor of the mouth cavity will be seen beating. This is actually the raising and lowering of the floor of the mouth cavity frequently. Since the mouth is closed during this activity, the air is drawn in and driven out of the mouth cavity, through the nostrils. The oxygen contained in the air is exchanged for carbon dioxide of the blood. The air that has received carbon dioxide is driven out through the nostrils. If you closely watch a frog breathing in this way for some time, you will find that at intervals, strong movements of the floor of the mouth taking place. On such occasions the lungs take part in the breathing as already described.

Respiration through skin : Frogs are remarkable in that they can respire even through their skin. That is why the skin of frogs is always kept moist. It is supplied with plenty of blood vessels containing blood with carbon dioxide. These vessels are separated only by thin walls from the outside air. This is the only type of respiration that takes place in frogs that are hibernating.

Differences between toads and frogs

Toads and frogs are very much alike in appearance, excepting for certain minor differences. Toads can easily be recognized by the presence of warts on their skin. The warts are small glands. You have seen that frogs have soft, smooth and moist skins. Toads have rough dry skin. When a toad is in danger of being attacked by an enemy, it can give off a milky fluid from its skin. This fluid is poisonous to some enemies of toad and thus keep them away. Generally frogs have slender bodies but toads have broad ones. Toads generally live in burrows and come out during nights in search of food. They have spurs on their feet which help in digging burrows.

You know that frogs have long hind limbs with well developed web in between the toes. Toads have limbs shorter in size and

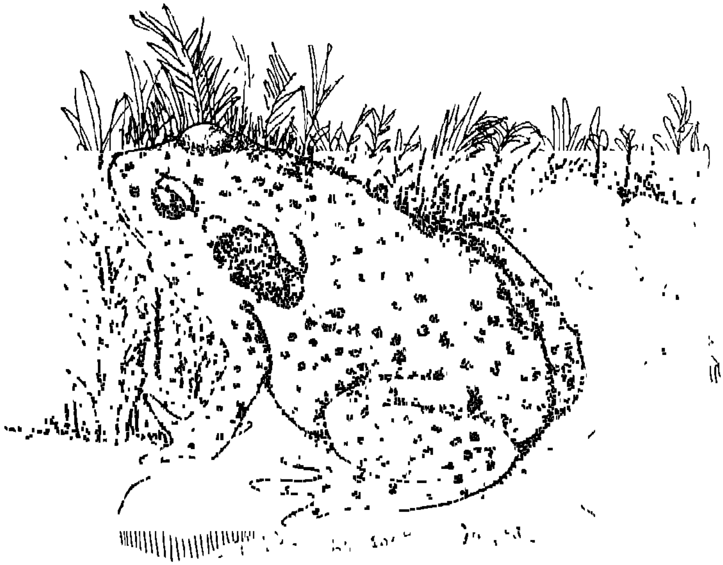


Fig. 9 5. Toad

the web in-between the toes is poorly developed. The eyes in toads are larger in size than those of the frogs. Frogs have minute teeth but toads have none.

Some people think that the milky fluids produced by the toads and even the urine of toads produce eruptions when they fall on the skin of the human beings. This belief is baseless. Toads do not cause any eruption.

Reproduction and Development

Does it surprise you, when you are told that there are male frogs and female frogs? Do you know how to distinguish a male frog from a female frog? Male frogs have vocal sacs but female frogs have none. The vocal sacs are pouches of skin one on either side near the floor of the mouth. Fully grown male frogs have pad-like swellings on one of the fingers in each hand. The swelling is pronounced in the season during which the female frogs lay eggs.

You might have listened to the loud croacking noise produced by the frogs during a rainy season. The sounds might have been of different kinds. These different kinds of sounds are produced by different kinds of frogs. It is usually the male that make such loud croaking noise. We talk and make noise, because we have vocal cords in our throats. Frogs also have vocal cords. They push air back and forth across the vocal cords and thus produce noise. In males this noise is made louder with the help of the vocal sacs. When a male frog makes noise, its vocal sacs fill up with air and puff out like baloons. Why does the frog make this noise? It is a sound by which female frogs are attracted. When a male frog finds a female it sits on it till the latter releases eggs into the water. You have seen that each female frog has a pair of ovaries. Each ovary contains a large number of ova or eggs. Each ovum has a nucleus in it. After these ova are fully grown they are passed through the oviduct and discharged out into the water. Male frogs have a pair of testes. The male frog discharges a fluid over the eggs released by the female frog. The fluid contains large numbers of minute sperms formed in the testes. Each sperm has a nucleus in it. One sperm fuses with each egg and then two nuclei unite. The union of the nucleus of ovum with that of the sperm is called fertilization. Inside each fertilized egg, a young frog begins to develop. The parents do not take care of the eggs nor do they take care of the young ones.

Development

During rainy season you may find whitish or yellowish spongy masses floating in ponds. These spongy masses contain a large numbers of eggs in them. The eggs can be seen as dark round structures surrounded by a covering of jelly-like substance. Bring a little of the spongy mass or spawn and leave it in any broad vessel containing water from the pond.

Observe the development of eggs. In a few days they develop into tiny fish-like living things. These are the young ones of frogs, the tadpoles. The tadpoles are very much different from the adult frogs. They grow for some time and later become adult frogs. You are already familiar with such changes in the growth of animals. This change is called metamorphosis.

Closely observe a tadpole under a lens. The new born tadpole is helpless. At first it has no eyes or mouth. It has a big head and a slender tail. It moves by lashing its tail. It is interesting to see them moving. At the front part of its head it has a sucker. With the help of the sucker it attaches itself to water plants and other objects. It has no mouth, but how does it take its food? The food for the developing tadpole is in the egg as yolk.

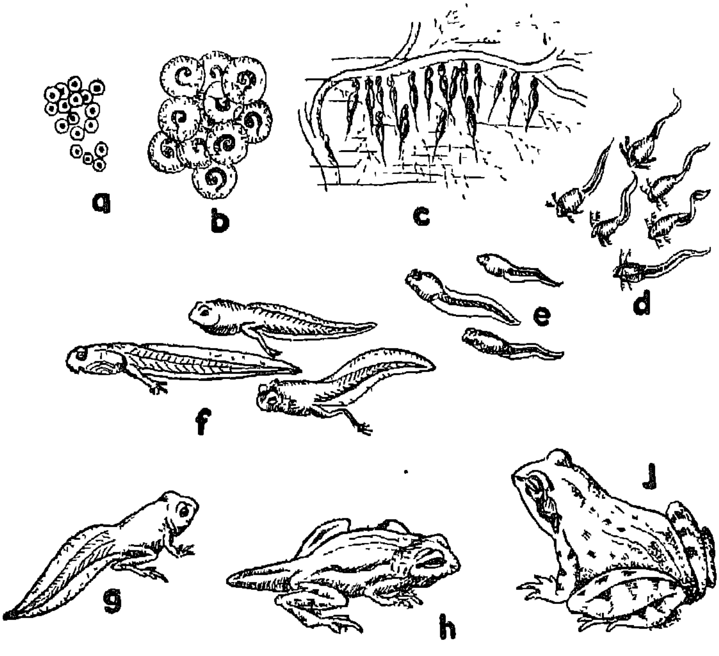


Fig. 9 6 Developmental stages of frog *a.* egg ; *b.* later stage , *c* tadpoles are hatched , *d* gills appear ; *e.* free swimming tadpoles ; *f* growth of hind limbs ; *g* growth of fore limbs ; *h.* the tadpole losing the tail ; *j.* Adult frog

At a later stage it develops a mouth. You will find two or three pairs of branched projections at the sides of its head. These are its gills. Since these gills are outside the body they are known as external gills. The external gills are its respiratory organs. It is with these gills that a tadpole takes in oxygen dissolved in water and gives out carbon dioxide. The tail develops a dorsal and a ventral fold and becomes a fin. The tadpole is now able to swim well by lashing its fin. It feeds on water plants.

You have learnt that the adult frogs feed on insects and other animals. But the tadpoles feed only on plants. Plant food takes longer time to get digested than animal food. Therefore, animals feeding on plant materials have long food canal to get their food digested. Tadpoles have a long food canal which is coiled like a watch spring.

After some time the external gills begin to disappear. New gills appear inside the head as in fishes. These are the internal gills. A tadpole with internal gills respires like a fish. It takes in water through its mouth and sends it out through the gills. The oxygen dissolved in the water is taken in by the blood contained in the arteries of the gills and the carbon dioxide escapes from the blood into the water.

By this time a pair of hind limbs appear at the region of the junction of the body with the tail. Forelimbs develop a little behind the head. Next the lungs develop inside. The coiled food canal is replaced by the permanent food canal of adult frogs. For some time the tadpole respires with its lungs and as well as its internal gills. The tail gradually gets reduced and the young frog hops about on land with a small tail. Finally the tail also disappears and the animal leads its life as a frog.

You might wonder at the enormous number of eggs produced by each female frog. If all these eggs develop into adult frogs, within a short time all the ponds, reservoirs and tanks would be filled with frogs. This never occurs. Since tadpoles are not fast swimmers and cannot protect themselves well, they are eaten by fishes, water insects and other animals. Very often after certain stage, tadpoles begin to eat one another. Only those tadpoles that manage to escape from these enemies, develop into adult frogs. The number of tadpoles that escape all their enemies and develop into adult frogs is very small.

§ TADPOLES : A COMPARISON AND CONTRAST WITH FISHES

You can compare a fish and a tadpole and find out in what respects tadpoles resemble fishes and in what respects they are different from the fishes.

Tadpoles resemble fishes in swimming in water with the help of the fins. Both possess gills and respire through them. But in a number of features, tadpoles are different from fishes. The nature of fins in tadpoles is very different from that of fishes. Fishes do not possess any limbs as do the tadpoles. Tadpoles undergo a number of changes during their very short life. First external gills appear, then internal gills develop and still later the lungs are formed. The nature of the mouth and the food canal changes. Such changes do not occur in a fish.

SUMMARY

Frogs are animals that spend part of their life in water and part on land. Frogs and other related animals are amphibians. Frog's body is made up of a head and trunk. There is no neck or tail. The two pairs of legs are dissimilar in size and shape. The forelimbs are shorter than the hind limbs. The hind limbs are strongly built and are useful in swimming in water and hopping on land.

Frogs live on animal food. Live and moving things are caught and eaten by frogs. They catch their food by their sticky tongues. Frogs respire through their lungs, mouth cavity and skin.

The eggs of frogs are laid in water. The young ones are called tadpoles which are a stage in the development of a frog. The tadpoles resemble the fishes in many respects than the adult frogs. The laying of a large number of eggs by frogs is an adaptation to compensate for the loss of a large number of young ones.

Toads are very similar to frogs, but differ from them in certain minor body features and habit.

Questions

1. How does a tadpole differ from a frog with regards to:
   (*a*) Respiration ?
   (*b*) Food and feeding habits ?
2. How are the limbs of frogs suited for living in water and on land ?
3. (*a*) What do you understand from the term "cold-blooded animal ?"
   (*b*) How does a frog escape from the extremes of heat and cold ?
4. You are given an amphibian. How will you find out whether it is a frog or a toad ?
5. It is said that "by seeing a kind of food which an animal eats, one can say what general type of food canal it has inside its body."

How far is this statement true of frogs and tadpole ?

Task

1. Obtain a frog and examine its external features.
2. Observe how a frog jumps on land and swims in water.
3. Examine and identify the various internal parts of a frog that has been dissected and exhibited.
4. Observe how a frog obtains its food.
5. Collect eggs of frogs and rear them in a vessel of water at house and observe periodically the changes that take place in tadpoles.
6. Obtain a fish and some tadpoles and find out the similarities and differences.
7. Obtain a frog and a toad and find out how they resemble and how they differ from one another.

CHAPTER X

Reptiles

If you happen to see a snake suddenly in front of you what would be your reaction ? You would get frightened and try to run away. Most people are afraid of snakes since they consider them to be poisonous, and believe that snake bite is quite often fatal. But all snakes are not poisonous. It is only a few kinds that are poisonous. It is these poisonous varieties that have brought a bad name to the whole group. Snakes are members of the group of animals called *Reptiles.* Wall lizards and the garden lizards are also members of this group. What are the characters that are common between a lizard and a snake? Why do biologists put them together in one group *viz. Reptilia* ? Turtles, tortoises, and crocodiles are also members of this group.

What are the common features between these animals ? They are all crawling animals. Their bodies are covered with scales and most of them reproduce by laying eggs.

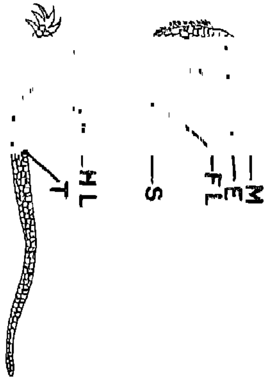


Fig. 10.1 Calotes . External features M. Mouth ; E. Eye ; F L, Forelimbs ; S. Scales; H.L. Hind limbs ; T Tail.

External Characters

The garden lizard is found in open fields and hedges. It feeds on insects. The body is made up of a head, a neck, a trunk and a tail. There are two pairs of limbs which end in claws. The body is covered with scales. A crest of spines is present on its dorsal (upper) side.

Examine and find out how the scales of a garden lizard are different from those of fishes. The scales of a garden lizard are horny and dry. Examine the head of a garden lizard and find out the various organs, like the mouth, eyes, nostrils and the ear membrane. Open its mouth and see whether teeth are present.

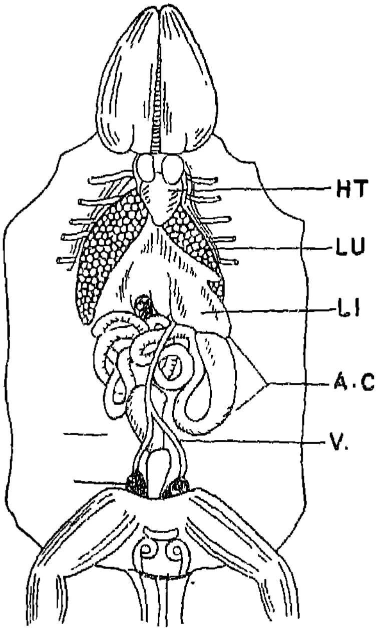


Fig 10.2. Dissected calotes to show the internal organs. Ht. Heart; LU. Lungs, Li. Liver; A.C. Alimentary canal, V. Blood Vessel.

Internal Organs

Examine the various internal organs of a garden lizard that has been dissected. Observe the heart relaxing and contracting. Note the difference between an artery and vein. Recognise the stomach, intestine and rectum of the alimentary canal. Find out the liver and the gall bladder.

With the help of a tube blow air through the mouth and see the lungs expanding. Push the alimentary canal to one side and locate the pair of kidneys. Distinguish the testes from the ovaries. Observe a number of nerves, some coming out through the backbone and some through the skull.

Locomotion

You might have been wondering as to how a lizard ascends up the walls without falling down. The toes of this animal have minute cup-like depressions at the ends. When these depressions are pressed against the wall, vacuum is created inside. This keeps the animal adhered to the walls.

Food and Feeding Habits

You must have seen a lizard catching insects. The lizards crawl on the walls near the lights. Can you guess, why ? The lights attract insects. Since the lizards feed mainly on insects, it can catch a large number of them near a light. As insects can fly away quickly they have to be caught quickly. When watching a lizard feeding, do not fail to observe how in a fraction of a second it snaps up an insect. If the insects are large, they carefully track them and catch them by their heads.

Escape From Enemies

Have you ever attempted to catch a lizard ? If you had tried to catch it by its tail, you would have failed to get it. Sometimes you might have seen the cat in your house trying to catch a lizard. If it catches it by its tail, the tail comes off from the lizard and the latter runs away. Meanwhile the cat will be looking at the wriggling tail, mistaking it for the lizard.

The lizard has lost only its tail temporarily, but it has saved its own life. The tail once again grows and assumes the normal size.

Reproduction

Lizards lay eggs. If you want to see the eggs of lizards, you should search for them in the crevices of walls. It lays small, white, round eggs. You have learnt that many fishes and frogs also lay eggs. How are the eggs of a lizard different from those of the fishes and frogs ? The eggs of lizards have a covering of a hard shell. Its eggs are laid on land. The embryo inside the egg develops fully. The young one that hatches out of the egg is a fully developed small lizard. The parents do not take care of either the eggs or the young ones.

§ 2. SNAKES

Snakes have long cylindrical bodies covered with scales. They have no limbs. The body consists of a head, trunk and tail. Examine the eyes of a snake. You will find that they have no eyelids. They remain open all the time. Observe closely the head of a snake and try to find the ears. You will not find them. There are no traces of external ears. Then how does a snake hear ? A snake cannot hear the sound that comes to it in air. It responds to the vibrations that are conveyed through the earth.

When a snake charmer brings a live snake and shows it to you, you might not fail to see two wiry things protruding out of the snake's mouth. This is its tongue, the tongue of snake is forked at its tip. Have you observed another interesting thing about the tongue ? The tongue can be protruded and withdrawn inside even when the mouth is closed. How is this possible ? If you examine a snake's jaw, you will find a notch in its upper jaw. It is through this the tongue moves in and out. Some people think that the snake's tongue is its poison organ. This guess is not right. With the help of its tongue a snake can smell things around it.

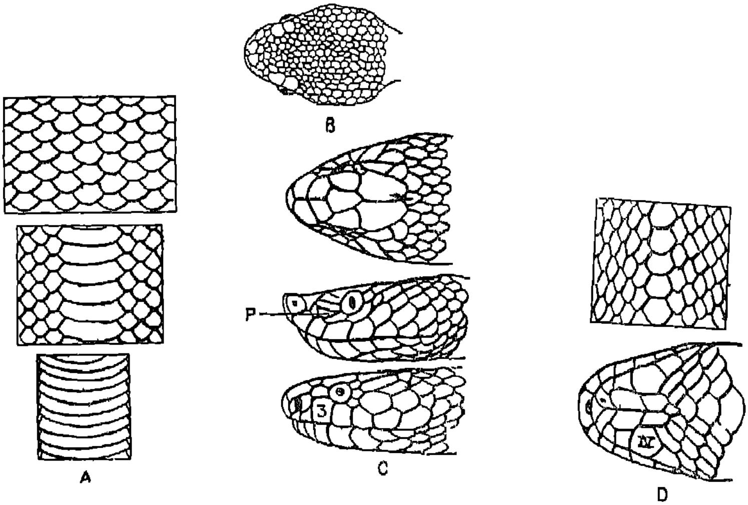


Fig. 10 3 Arrangement of scales in snakes
A Nonpoisonous snakes, B. May be poisonous or nonpoisonous snake; C Viper; P. Pit; D. Krait

The head of a snake has large plates of scales, and they are called shields. If you examine the arrangement of the scales and shields in different kinds of snakes, you will find them differing from one another. In fact, zoologists recognise a particular snake from the arrangement of its scales and shields. If you leave a snake on a glass plate, it cannot move. Do you know why? Snakes move with the help of the scales situated on its ventral (lower) side. On a rough surface the scales can get a grip and move. On smooth surfaces such a grip is not possible, therefore they cannot move. Have you seen thin transparent skin cast off by snakes on hedges? These are called moults. Snakes have the habit of casting off their skins periodically. The casting off of the skin is known as moulting. At the time of moulting, a snake cannot see properly, it becomes temporarily blind. After moulting its skin, it can see well.

Snakes feed on frogs, lizards, birds, rats, insects and even other snakes. It is surprising to see snakes sometimes eating animals much bigger than their own size. How are these large animals swallowed through the narrow mouth ? The lower jaw of the snake is in two parts. The two separate halves are connected by an elastic tissue. The lower jaw is loosely attached to the upper jaw and because of this, a snake can stretch and open its jaws widely in order to swallow bigger animals. The prey is swallowed as a whole. The jaws of the snake have small pointed teeth. They are not meant for chewing. Observe closely these teeth. Do you see them pointing backwards ? These teeth prevent the prey from escaping out. Some snakes after a heavy meal can go without food for several weeks.

Each variety of snake has male snakes and female snakes. Only the female snakes lay eggs. Some snakes do not lay eggs but give birth to young live snakes.

§ 3. NON-POISONOUS AND POISONOUS SNAKES

Very few snakes are poisonous. There are more of non-poisonous snakes than poisonous ones. Some examples of non-poisonous are the python, water snake and rat snake.

Pythons are the largest among snakes. They can grow to about 5-6 metres in length and weigh about 100 kg. It can climb trees and swim in water as well. It usually coils around its large prey and kills it by pressing hard its victim in its coils. Well grown python can eat a deer as a whole.

Water snake is commonly found in fresh water ponds and on land. They feed on frogs and rats. There is no danger for human life from non-poisonous snakes. In fact non-poisonous snakes live on rats, mice and other similar animals that cause great damage to our food materials.

Poisonous Snakes

The common poisonous snakes found in our country are the cobras, vipers, kraits and sea snakes. The ventral scales in many poisonous snakes are broad (Fig. 10.3). This and the making on its body can help in identifying poisonous snakes.

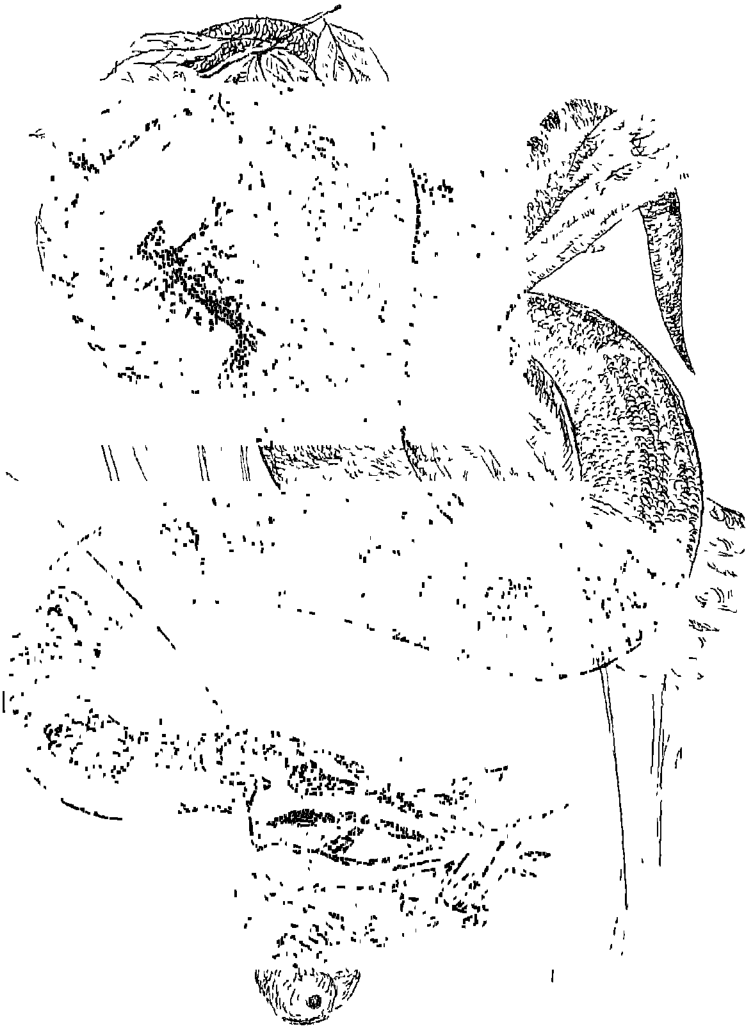


Fig. 10 4. Python.

Cobras

Cobras are highly poisonous. With their hoods they are beautiful to look at. The hood becomes very prominent when expanded. Most cobras have a 'V'—shaped mark on the hood.

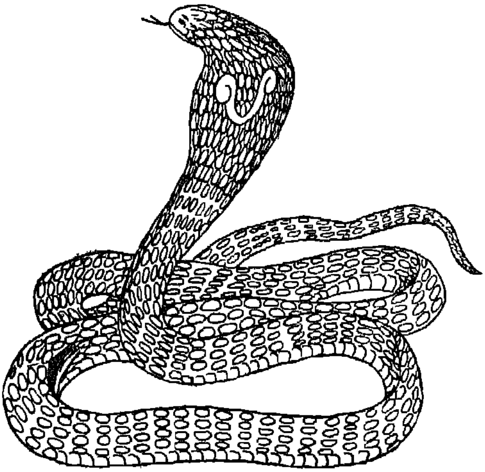


Fig. 10.5. Cobra.

Krait

A krait has white cross bands on its back. These bands are distinct posteriorly but fade away anteriorly (Fig. 10.3). There

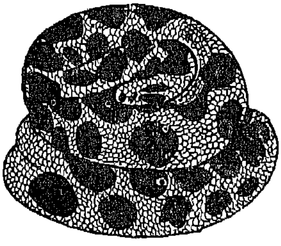


Fig. 10.6. Krait.

is a common non-poisonous snake called wolf-snake. This resembles superficially a krait. But in the wolf snake, the bands are distinctly seen in the anterior region but they fade away in the posterior region.

Viper

There are many kinds of vipers. Russell's viper is a stout reddish brown snake. It has longitudinal rows of diamond-shaped markings on the back and sides. The viper retains its eggs inside its body and gives birth to live young ones. Russell's viper is a very poisonous snake.

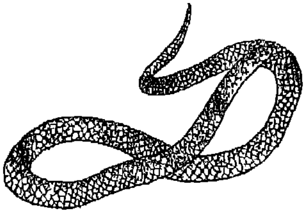


Fig. 10.7. Viper.

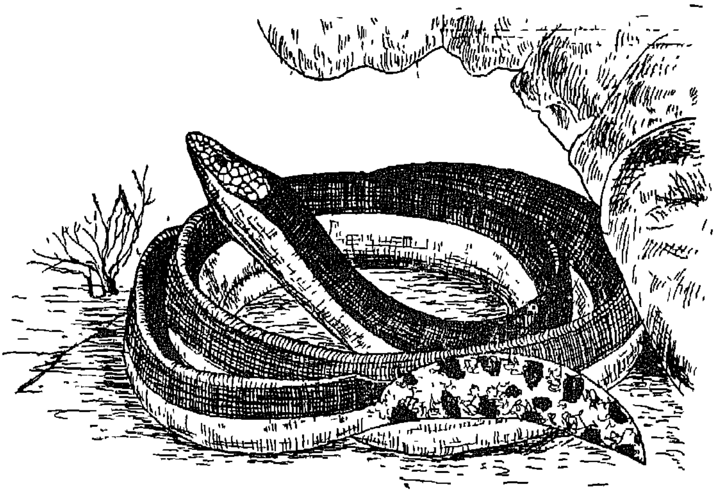


Fig. 10.8. Sea—snake.

Sea-snakes

Sea-snakes have tails that are compressed at the sides. They are all poisonous. Normally the sea snakes are sluggish and do not bite unless provoked.

Poison apparatus

The poison apparatus of a poisonous snake consists of a pair of poison glands, ducts and fangs. The poison glands lie one on either side of the head below the eye and a little behind it. There are two fangs, one on either side at the front part of the upper jaw. The fangs are grooved. The poison secreted in the glands is conducted to the fangs through ducts. The fangs of cobra and the krait are grooved, whereas those of the viper are tubular.

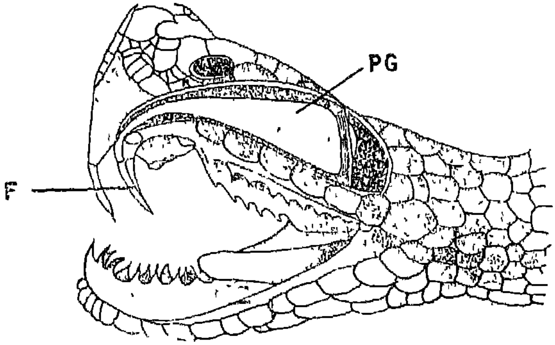


Fig 10.9. Poison apparatus of snake.

Nature of the Snake Poison

A poisonous snake uses its poison against its enemies and for killing its prey. Very often a poisonous snake bites its prey injecting its poison into it. Then it eats its prey along with its poison injected into it. It does no harm to it. We even can safely take the snake poison in our mouth provided there are no ulcers in our mouth. If there are ulcers in our mouth, the poison will get into our blood. The poison acts only when it gets into the blood stream.

The venom of the cobra and the krait acts chiefly on the brain and the spinal cord of the victims. In cobra bites, there is at first a paralysis of the limbs and this gradually extends to the muscles of the body and head. Death results due to the stoppage of respiration. The poison of krait, in addition to producing paralysis, also leads to bleeding in the alimentary canal. The poison of viper affects the heart and the blood vessels. In this case there is no paralysis. There is profuse internal bleeding in various parts of the body.

First Aid For Snake Bite

If there is a snake bite and the snake is poisonous, one should not be frightened and lose courage. It is believed that many people bitten by snakes die due to shock or fear than due to the poison. Sometimes people who were bitten by non-poisonous snakes are also reported to have died merely because of the fear.

At first a thin piece of cloth should be tied around the region of the body above the place of snake-bite. Then a cut should be made at the wound with a clean sharp blade. The blood should then be sucked out. It can be done with mouth, if there are no ulcers or wounds in it. Otherwise the blood can be sucked out with a suction apparatus. The patient should be taken to a doctor after this first aid.

§ 4. SOME MODERN REPTILES

Chameleon

Chameleon is closely related to lizards. One very interesting feature about chameleons is that they can change their colour. Chameleon can remain firmly gripped to its support with the help of its limbs and tail. It has a long, club-shaped tongue with which it shoots at its prey. It can rotate its eyes in different directions, independant of one another and thus get a good view of the area all around.

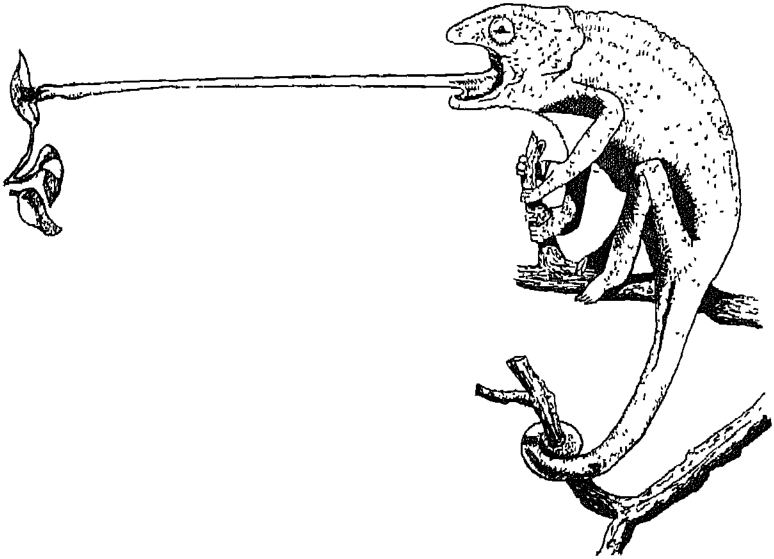


Fig. 10.10. Chameleon.

Turtles

The body of a turtle is encased in a bony shell. The shell is covered on its outside with scales. When threatened by

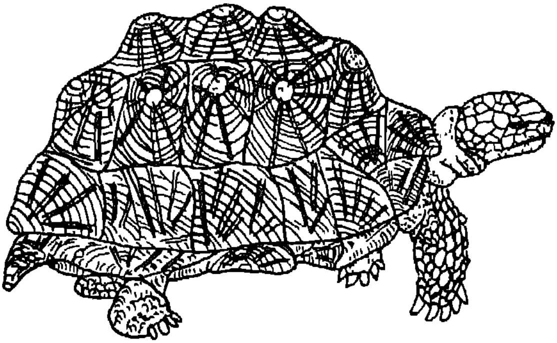


Fig. 10.11. Tortoise.

enemies a turtle can withdraw its limbs and head inside its bony armour and lies quiet. Turtles have no teeth, instead they have a horny plates on their jaws.

Sometimes the name turtle is applied to those forms found in the sea; tortoise to the land forms and terrapin to the land fresh water forms. All of them lay eggs. They all breath by means of lungs. Therefore you can frequently see them coming up to the surface of the water for breathing.

Crocodiles

The crocodiles have a lizard-like body with a long snout. They live in fresh water and often avoid sea water. The skin is thick and leathery and is covered with horny scales. They feed on fishes, mammals and birds. They often come to the shore and attack human beings and grazing animals.

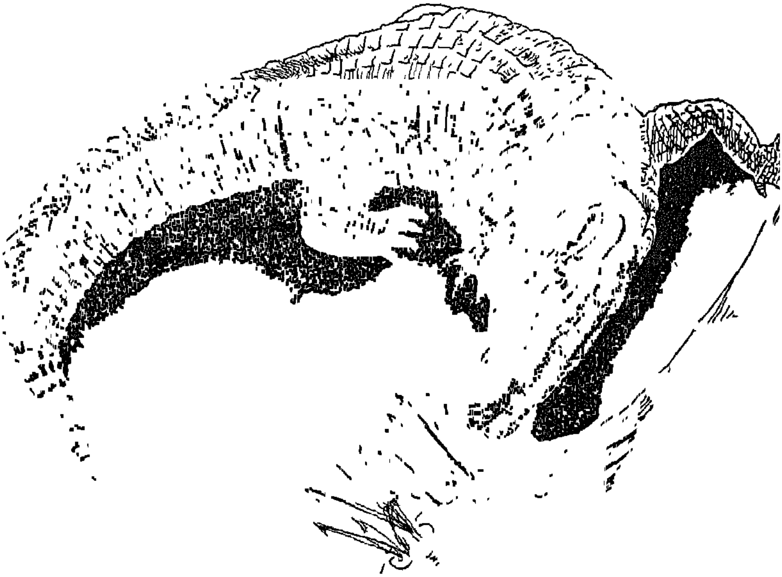


Fig. 10.12. Crocodile.

The hind limbs of crocodiles are webbed. This is an adaptation for their life in water.

§ 5. REPTILES OF THE PAST AND THEIR EXTINCTION

Look at the figures of some of the animals that are given in Fig. 10.13. Can you imagine what kind of animals these are?

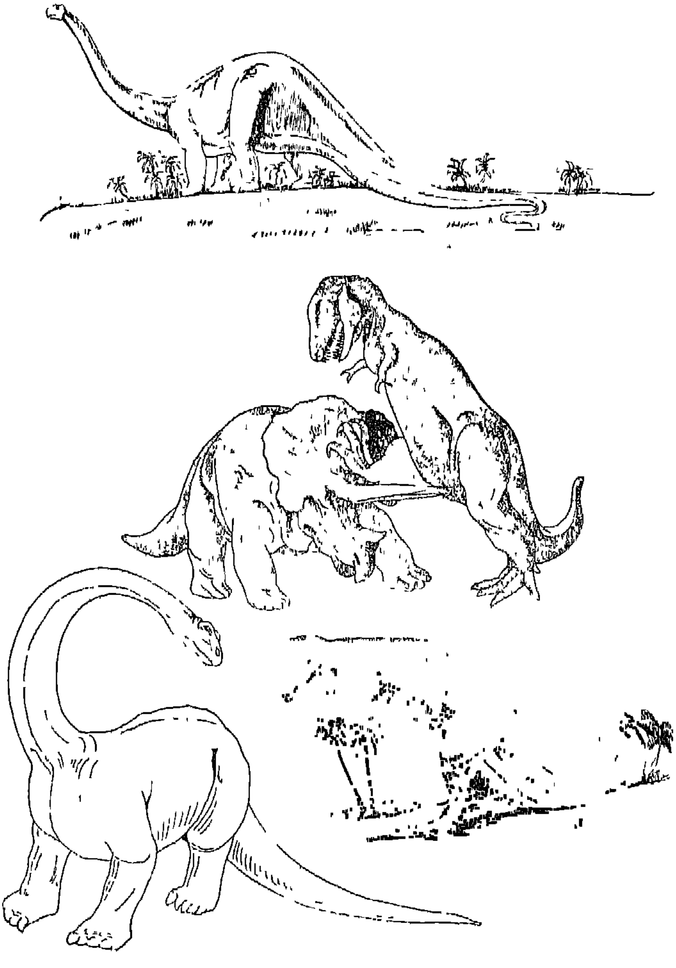


Fig. 10.13. Dinosaurs.

These are reptiles but you do not find them living in any part of the world to-day. They lived on this earth millions of years ago. Can you imagine a period of 135 million years. These reptiles dominated this earth about 135 million years ago. During that period man did not live on this earth. These reptiles were found everywhere. How do we know this fact? We know because we have found their fossils embedded in between layers of ancient rock. From the fossils of their skeletons, scientists have constructed models of these reptiles. These creatures were very huge reptiles. These fossil reptiles are collectively called *dinosaurs.* Do you know what it means? Dinosaurs mean 'terrible lizards'. These were indeed terrible lizards. Many of them were huge reptiles. Can you imagine the size of the reptiles you see in fig. 10.13 ? It would take at least eight elephants standing in line to reach from its head to the tip of its tail. It can easily peep into a three storied building while itself remaining on the ground. There were other dinosaurs that were larger and more strongly built than these.

Compared to the present day reptiles the dinosaurs were all real giants. Some of them were plant-eating while some others were flesh-eating. You can guess which of the reptiles given in the picture could have been flesh eating ones by seeing the nature of their teeth. Dinosaurs lived on land. There were other huge reptiles that lived in water and some others that could fly in the air.

All these ancient reptiles disappeared from this world long ago. They are said to have become extinct. Why did all these dinosaurs and other ancient reptiles disappear? The reason is not known. Certain changes that are believed to have taken place on this land at that time were perhaps responsible for their disappearance. The swamps and ponds perhaps began to dry up. Plant food of herbivorous dinosaurs became scarce. Therefore many plant-eating dinosaurs disappeared. Since the flesh-eating forms depended upon these plant-eating forms, the former also began to decrease in numbers. The climate became cold. Since the reptiles were used to warm climates, they could not stand this sudden change.

Though most of the ancient reptiles disappeared, some forms continued to survive. From such forms the modern reptiles, birds and mammals are believed to have arisen.

§ 6. GENERAL CHARACTERS OF REPTILES

Reptiles are crawling animals. Their body is covered with scales. They lay eggs on land. The young ones hatch out of the eggs fully developed.

SUMMARY

Lizards, turtles, snakes and crocodiles are collectively called reptiles. All reptiles are crawling animals with their body covered with scales. Many reptiles lay eggs on land, some retain their eggs inside their body to give birth to live young ones. All reptiles are adapted for the mode of life they lead. The adaptation of lizards can be clearly seen in their locomotion, food and feeding habits, protection against their enemies and on their method of reproduction.

The snakes are limbless reptiles. Some are poisonous but many are non poisonous. Cobra, krait, viper and seasnakes are among the poisonous forms. Python, water snake, are some of the non-poisonous ones. The poison apparatus of a snake consists of a pair of poison glands, ducts and fangs. Snake poison paralyses the nerves and might cause internal bleeding.

About 135 million years ago this earth was dominated by reptiles. It was the age of reptiles. Many monster reptiles known as dinosaurs existed on this earth. The fossils of these reptiles discovered from different parts of the world give us a clue to their structure and ways of life. Many ancient reptiles became extinct due to changes in the climate of the earth and the consequent food scarcity. But some reptiles survived these changes and gave rise to the modern reptiles, birds and mammals.

Questions

(1) How is it possible for a lizard to walk on the roof upside down?

(2) How are snakes adapted for their mode of life?

(3) (*a*) What is moulting?

(*b*) Which among the reptiles are known to moult?

(4) How is it possible for a snake to swallow animals much bigger than itself?

(5) (*a*) How does the snake poison effect our body?

(*b*) What is the first aid you will give in case of snake bite?

(6) Give a short account of ancient reptiles and the probable causes for their extinction.

Tasks

1. Observe the feeding habits, and locomotion of a house lizard.
2. Study the external features and the internal parts of a dissected garden lizard.
3. Observe some of the preserved poisonous snakes available in your locality.

4. Observe the locomotion, feeding habits of a snake brought by a snake charmer.

5. Make models of some of the ancient reptiles.

Chapter 11

Birds

Amphibians, reptiles and birds are all animals with a vertebral column. You have seen how the amphibians differ from the reptiles. In spite of the differences there are certain things that are common to both these groups. One important common feature is that both these groups of animals are cold blooded animals. You also know what is meant by a cold blooded animal. But even though birds have a vertebral column, they differ from the amphibians and reptiles, in that they are warm-blooded. Warm-blooded animals are those in which the body temperature does not dependent upon its surroundings. It remains constant and even when the surrounding is cold the body remains warm.

Birds as a group of animals are adapted for flying in the air. How is the body of a bird adapted for its flying habit ? Almost every organ of a bird is greatly modified in relation to its life in the air. You have seen that animals living on land have two pairs of legs. In birds the fore limbs are modified into wings. The feathers borne by the forelimbs are specially modified to help the animal in flying. Their body is streamlined and thus have less resistance to air during flight. Similarly their beaks and heads are also pointed to reduce the air resistance. The tail is very short and bears feathers, which are used for steering during flight. To move the wings efficiently during flight the pectoral muscles are well developed. The breast bone is produced into a prominent keel for the attachment of these muscles. In air the main problem of the flying animals will be their weight. The birds have succeeded in reducing their body weight, remarkably. The bones are hollow due to air cavities inside them. This make the bones weigh less.

External characters

The body of a pigeon can be divided into a round head, a long mobile neck, a boat shaped trunk and a small tail. The head is drawn in front as the beak. The mouth is a slit-like opening. At the base of the beak there is a pair of nostrils. A small patch of swollen skin called *cere* overhangs the nostril. The eyes lie behind the cere. Each eye is provided with upper and lower eyelids and a transparent membrane. Behind and slightly below the eyes are the two openings of the ears.

The trunk bears a pair of wings in front and a pair of legs behind. The wings are the modified forelimbs. Each forelimb has an upper arm, a forearm and a hand. The hand bears three digits. When the pigeon is at rest, the three divisions of the forearm are bent upon one another. This is extended

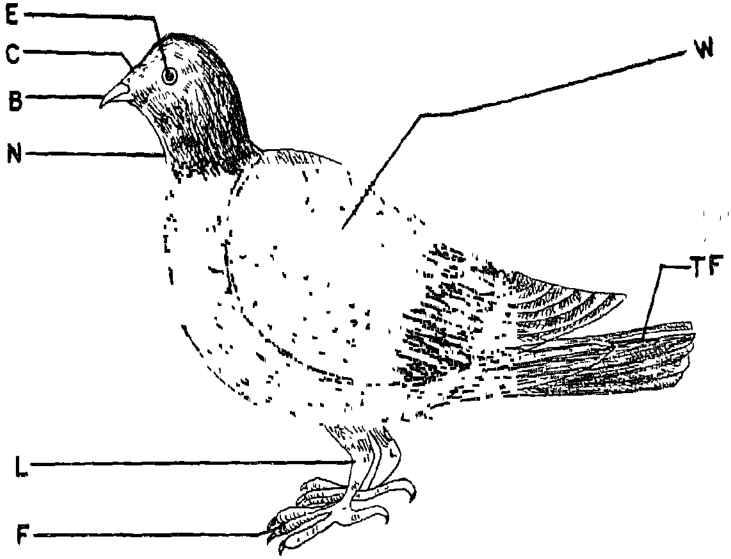


Fig. 11.1 Pigeon · External features E. Eye : C Cere ; B. Beak ; N. Neck ; W. Wing ; T. F. Tail feathers ; L. Leg ; F. Foot

while flying. Since the forelimbs are modified for flight the whole weight of the body is supported by the legs. The legs are therefore attached far forwards on the body so that the body is balanced on them. The legs are covered with scales. There are four digits in each foot. The first toe is directed backwards.

The tail is small and is covered with feathers. On the lower surface at the root of the tail, is an opening. In some

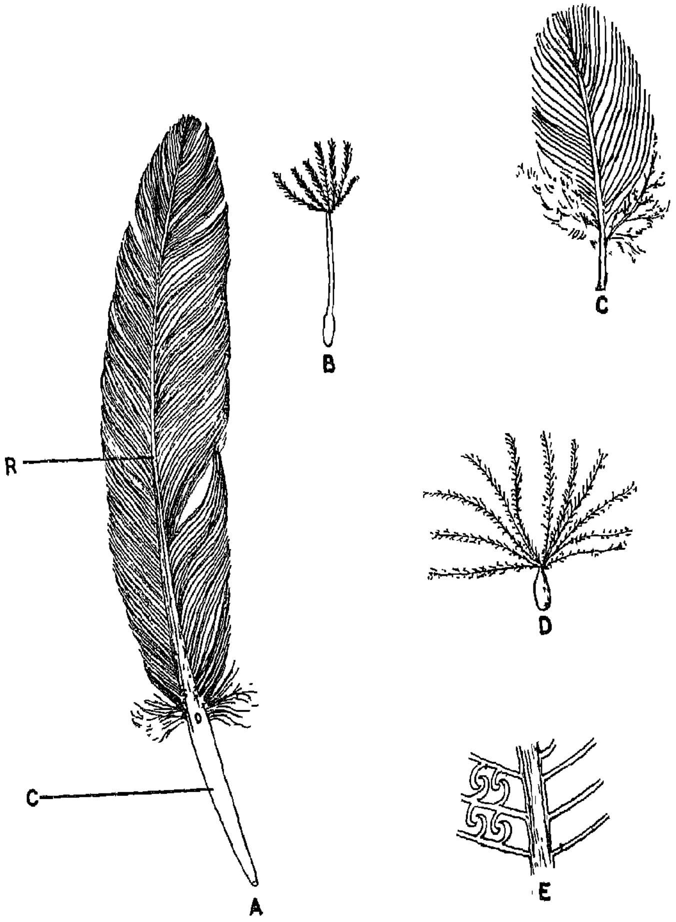


Fig. 11.2 Different kinds of feathers A & C. Contour feather; C. Calamus . R. Rachis B. Filoplume; D. Down feather; E. Interlocking of barbules.

vertebrates the last portion of the rectum and the reproductive passage are one and the same. This is called the cloaca and it opens to the outside under the tail as stated above. Above the tail is a knob on which an oil gland opens. The fluid secreted by this gland is used for preening the feathers. The surface of the body of pigeon is covered with feathers. The presence of feathers is a uniqe feature, of all birds. There is no bird without feathers. The feathers are of different kinds, the most common among them are the contour feathers, down feathers and filoplumes. The contour feathers cover the whole body, neck, head, wing and tail and are often brilliantly coloured. Contour feathers are well developed in the wings and the tail. The contour feathers are not distributed on the entire surface of the body of a bird. They are restricted to certain tracts. This can be clearly seen when a bird is plucked.

Different parts can be recognized in a single feather. The

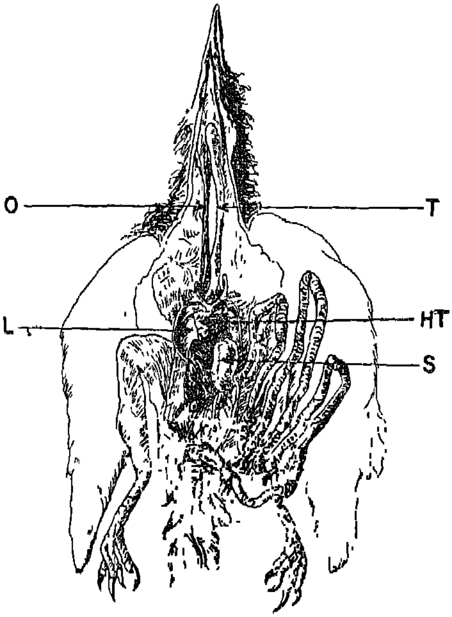


Fig. 11.3. Pigeon: Internal organs O Oesophagus; T. trachea; L. Lungs; Ht. Heart; S. Stomach.

central stem is made up of two portions the lower hollow quill and the upper solid rachis. At the junction of quill with the rachis, there is a small tuft of soft feathers known as after shaft. The rachis bears on each side a row of parallel filaments called barbs.

Down feathers are small soft feathers. They are situated close to the surface of the body. They aid in keeping the bird warm. The filoplumes have a slender hair-like stem and a tuft of fine feathers.

Internal Structure

You are now familar with the names of the internal organs of different systems. You can see the different systems, in the body of a pigeon that is kept dissected.

Digestive System

Digestive system helps the animal in digesting the food materials and absorbing the nutrients. In pigeon as in other vertebrate animals the alimentary canal starts from the mouth. The mouth leads into a long tubular oesophaghus. The pigeons do not chew their food but simply swallow it. The food thus swallowed reaches the crop. The crop stores temporarily the food taken. By dissecting out the crop you can find out what food materials, the pigeon has eaten. From the crop the food passes through a small tube to a highly muscular organ called gizzard. The food is ground well in the gizzard. You will find in the gizzard small stones swallowed by the pigeon. These stones help in grinding well the food materials. The intestine is a long coiled tube ending in the cloaca. Liver, pancreas and gall-bladder are all connected with the digestive system.

Respiratory System

There is a pair of lungs and connected to them are a number of thin walled sacs. These are called air sacs. They extend between many organs in the thorax, abdomen and even into some bones. You have seen that the lungs in frog and garden lizard are full of sacs with thin walls. How are the lungs of pigeon different from those of frogs and garden lizards ? The lungs of birds are spongy. They do not freely hang in the body cavity. They are attached to ribs.

Circulatory System

The blood vessels which appear bluish red in colour are the veins. They bring the blood containing carbon dioxide from all parts of the body to the heart. From the heart this blood is taken to lungs and purified. In this purification carbon

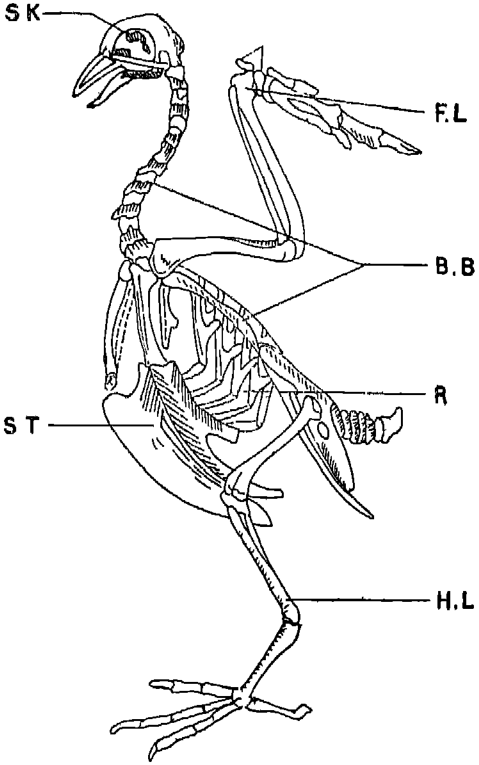


Fig. 11.4 Skeleton of pigeon. Sk. Skull , St. sternum ; F L. Fore limbs ; B.B. Back bone ; R. Ribs ; H.L. Hind limbs.

dioxide is given out and oxygen is taken into the blood. The blood containing oxygen is brought back to the heart. They are then distributed to various organs by the blood vessels called arteries. The arteries appear red in colour.

Excretory System

The kidney filters the waste products from the blood and expels them as the urine. The kidney of pigeon is made up of three lobes.

Skeletal and Muscular System

These two systems help the animal in its locomotion. Examine the skeleton of the wings of a bird. Compare this with the forelimb of any land vertebrate and you will find that the wing in a bird is really the modified forelimb.

Nervous System

The system consists of the brain and a number of nerves.

Reproductive system

The males possess a pair of testes. The sperm is conducted through the canals connected with each testis.

In females there is a single ovary on the left side. The oviduct opens in front by a funnel like opening. As the ova pass through the oviduct the albumen, membrane and the shell are formed. An egg does not wait to be fertilized by the sperm. If the sperm is present during its passage before the shell and other structures are formed it gets fertilized. Even if it is not fertilized, the development is completed and the egg is laid.

Unfertilized egg does not have a living embryo inside it and on incubation it cannot give rise to a chick.

Structure of an egg

All birds reproduce by eggs. A bird's egg is oval or roundish in shape. The eggs of different birds may have different colours. The egg of ostrich is the largest egg known of any living animal.

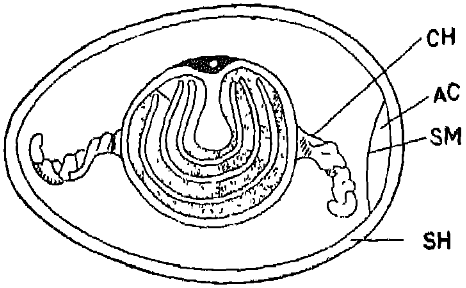


Fig. 11.5 The egg of chick CH. Chalaza; AC. Air chamber: SM. Semipermeable membrane; SH. Shell.

A bird's egg is covered with a shell. The shell is porous and allows the passage of air inside the egg. Beneath the shell is the shell membrane made up of two layers. The two layers separate at the broad end of the egg to form an air chamber. The albumen or the white of the egg fills the egg cavity. At either ends of the albumen two twisted cords of gelatinous material is seen. They help in keeping the ovum in position. Inner to the albumen is the ovum with an enormous quantity of yolk. On one side of the ovum is a disc. The embryo develops in the disc portion.

Conditions necessary for development of an egg

For the eggs of reptiles to develop the heat of the sun is enough. But the eggs of birds cannot develop at that temperature. They require a higher temperature. They develop at 38°-40°c. You might have seen birds sitting on their eggs. The birds maintain the temperature required for the eggs to develop by sitting on them. This is known as incubation.

Hatching

Incubation lasts for fourteen days in pigeon and twenty one days in the fowl. At the end of the period, the young one emerges from the egg, breaking the shell on one side. The young pigeons that hatch out of the eggs are blind and covered with very little of the soft feathers. They are fed by the parents with white creamy thing secreted in the crop. This is called pigeon's milk. The young pigeons do not open their mouths to be fed by their parents. They put their beaks into their parents beaks and take in the pigeon's milk that comes from the crop.

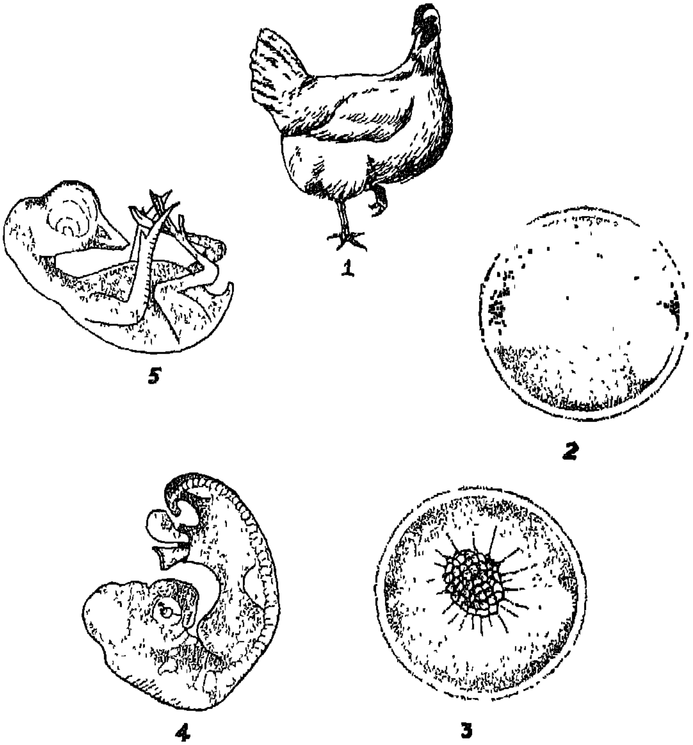


Fig. 11.6. Developmental stages of a chick.

Nests of Birds

You might have seen that hen lays eggs all through the year. But many birds have a definite breeding season. During that season they lay eggs. At the approach of the breeding season, the birds start constructing nests in different places. Birds like eagles, vultures, and kites build their nests either on tree tops, or on stony hill tops. Owls build their nests in holes of trees or walls or on the ground in the shelter of bushes. Wood peckers, parakeets and mynas make their nests in holes in trees. Sparrows build their nests in any small hole in any part of the building or tree. Thus birds make nests in many places: banks of rivers or ponds. or mountain tops, trees, or buildings.

Grass, twigs, and leaves are the chief materials utilized by birds for buildings nests. Some birds make use of feathers and

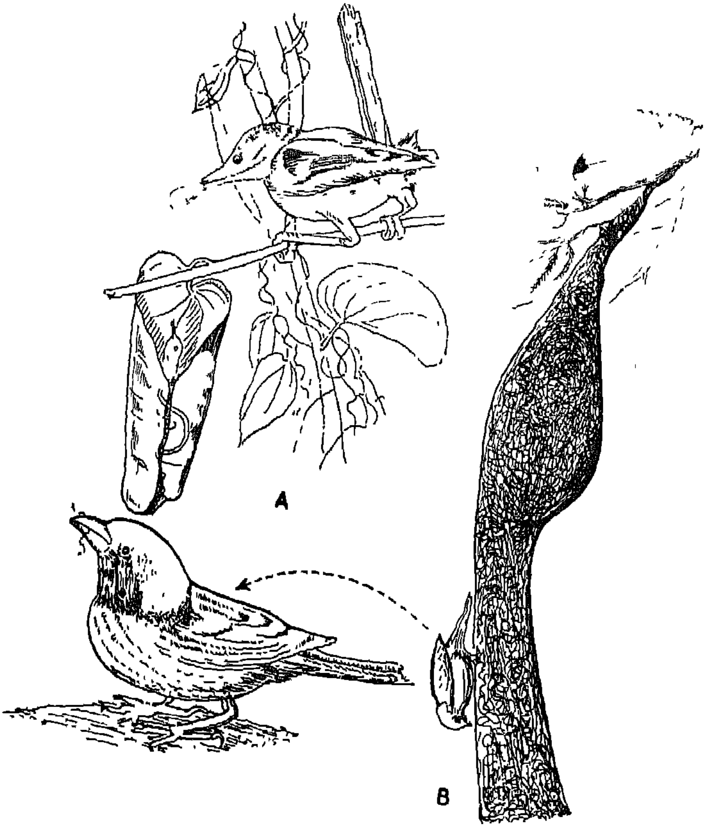


Fig. 11.7. Some interesting nests of birds :
A. Tailor bird ; B. Weaver bird.

pieces of cloth or string are used as cushions for eggs and young birds (Fig. 11.7).

Certain birds like tailor birds and weaver birds make interesting kinds of nests.

To make a nest the talior bird selects two broad leaves. The male bird makes holes at the margins with its sharp bill. Then strands of string-like material are passed through the holes and the edges of the two leaves are sewn together. Thus the two leaves form a tubular pocket. It is then filled with soft material and eggs are laid inside this nest.

The weaver bird makes a beautiful nest with coconut fibres, or grass. The nests are suspended from the branches of trees. The opening is directed downward. There are two chambers in the nest. The upper one is for the eggs and the lower one is for the entrance.

Birds and Reptiles : Comparison and Contrast

Birds are adapted for flying. Therefore many of their body features are suited for flying habits. But still, in certain respects birds resemble the reptiles. You have seen that the body of reptiles are covered with scales. In birds the body is covered with feathers but the hind limbs are still covered with scales. Some of the internal organs of birds like the heart and brain still resemble those of the reptiles. You have learnt previously that the ova and sperms of fishes and amphibians are fertilized out side the body, *i.e.* fertilization is external. In birds and reptiles fertilization is internal. The eggs of fishes and amphibians develop in water. But the eggs of birds and reptiles can develop on land. The eggs of these animals contain plenty of yolk,

Though the birds resemble the reptiles in some features, in certain other features, they are different from them. You have seen that most of the reptiles have teeth in their mouth. The birds do not have teeth. In reptiles the tail is long but in birds the tail is very much reduced.

The modern reptiles and birds resemble each other in some features, and differ from each other in certain other respects.

But a remarkable fossil bird that was recovered shows combined features of both reptiles and birds. The bird is now called by the name *Archaeopteryx* (Fig. 11. 8). It had feathers like all other living birds. But it had a long tail and teeth in its beak. The forelimbs though modified as wing, still retained features of the forelimbs of reptiles.

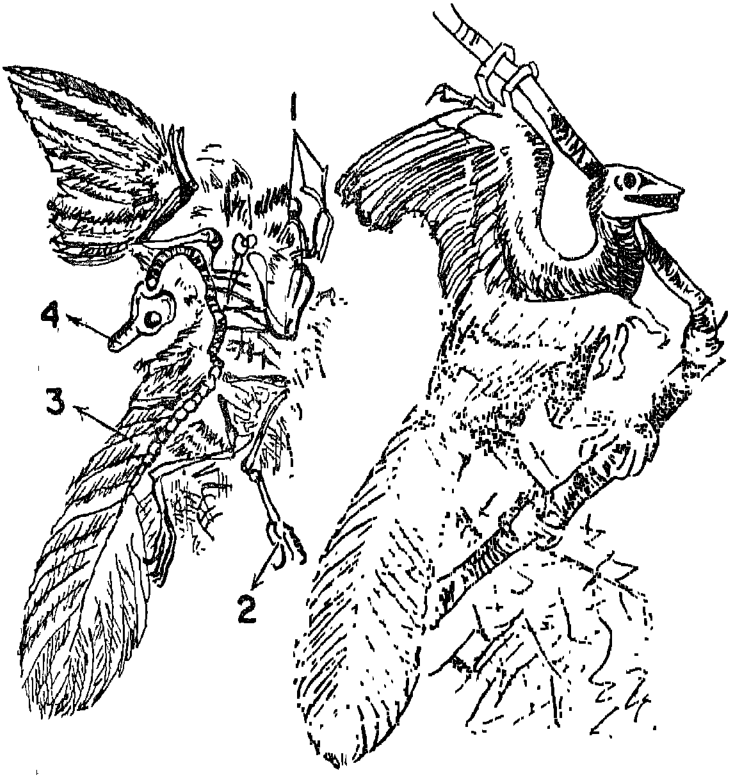


Fig. 11.8. Archaeopteryx : Fossil and reconstructed one.
1. Fore limbs, 2. Hind limbs ; 3. Tail ; 4. Beak.

The scientists believe that *Archaeopteryx* lived in this world when no other bird was known. It is considered to be the earlist known bird. From its descendants the modern birds arose. Since *Archaeopteryx* is intermediate in its characteristics between a reptile and a bird, it is believed that it orginated from a reptile. All modern birds descended from *Archaeopteryx* and *Archaeopteryx* itself originated from a reptile.

Adaptations of Birds to various Modes of life.

Birds present a great variety in their habitat and modes of life. The organs that show the greatest modification with regard to their modes of life are the beaks and feet. These organs are adapted for the type of food they eat and the mode of life they lead. By seeing the nature of the beak and feet of a bird one can learn its way of life.

The sparrow feeds on grains and seeds. Adapted to its food, the sparrow has short and straight beak. This helps in picking up seeds and grains and crushing them. In the woodpecker the beak is chisel-shaped for drilling or making holes in trees, and of the four toes of a woodpecker two are directed forwards and two backwards. This facilitates climbing on trees. In eagles, hawks, and owls the beak is strong and curved for catching prey and tearing its flesh. Their toes have strong curved claws for catching other animals. In ducks, the beak is broad and notched for scooping or dreadging and straining mud. To swim in water their toes are webbed. In cranes and herons the beak is long for catching fish and other organisms from water. Since they are wading birds they have long legs. These help to keep the body above the water level.

Flightless birds

Most birds fly. But there are certain birds that cannot fly. You might have heard about the ostrich. Ostrich is found in Africa. It cannot fly. It has a huge body. The wings are reduced. How does it escape from its enemies ? It can run fast, as fast as a horse. It has powerful legs. It can give

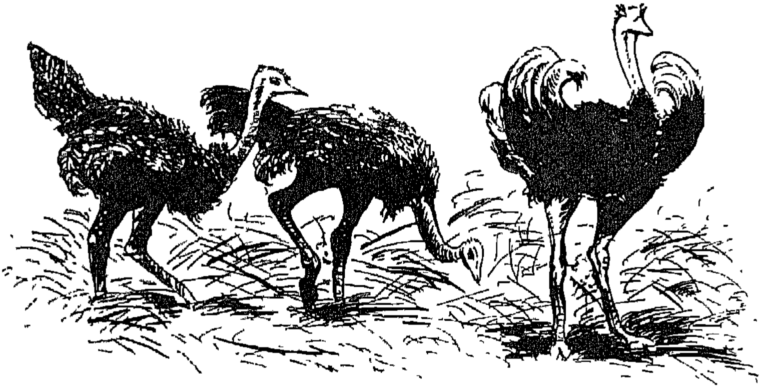


Fig. 11.9. Ostrich.

strong kicks with its legs. Many of the adaptations found in flying birds are absent in this bird. The tail is much reduced. The wing muscles are not well developed. The breast bone is not keel shaped as in flying birds. There are many other flightless birds. Penguins found in certain cold regions of the world are also flightless birds.

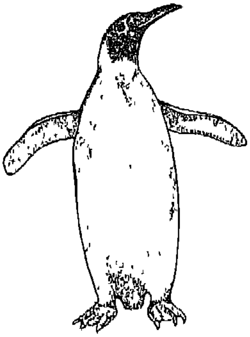


Fig. 11.10. Penguin

COMMON FEATURES OF BIRDS

Birds are warm-blooded vertberates with their body covered with feathers. They have scales in their legs. The fore-limbs are modified into wings. They have a beak without teeth. Their bones are light with hollow spaces inside. The lungs have large air sacs. The hind limbs have four toes. The hind limbs are attached far in front to support the weight of the whole body.

SOME INTERESTING BIRDS

Red Vented Bulbul (Fig. 11.11 A)

This is a small bird, smoky brown in colour. It has a crest on its head and a red patch under its tail. It can be seen on trees flying from branch to branch seeking fruits and insects for its food. It builds cup-shaped nests amongst bushy plants in gardens and parks.

Babblers or Seven Sisters (Fig. 11.11 B)

The Babbler has a dull ash-coloured body. It has the habit of searching among dry leaves for insects and worms. The colour of the body merges with the colour of brown dried leaves. These birds are always seen in groups of six or seven birds. Therefore, they are called seven-sisters. Their tails are long and flop loosely as they hop about in noisy companionship.

Vultures (Fig. 11.11 C)

Vultures are big birds, brown in colour. The head and neck are naked and their wings are large. They feed on dead animals. Thus they are the Nature's scavengers. Often they feed as a large group on the dead animals.

King fisher (Fig. 11.11 D)

The common king fisher is slightly larger than a sparrow. It has a brilliant blue colour. It has a long strong bill. There is another kind of king fisher—white breasted king fisher. They have blue coloured wings and white coloured chest and the beaks are red.

King fishers sit near the water and wait for fish. Some make a flying survey. As soon as a fish is seen the wings are closed and the bird dives into the water. It then flies off with the prey in its beak. King-fishers make nests in earth banks. The nest is a long narrow horizontal tunnel.

Hoopoe (Fig. 11.11 E)

Hoopoe is a beautiful bird with a long pointed beak. It has a beautiful crest which is raised periodically. It ordinarily appears brown in colour. When it flies the prominent white and black steaks are seen. It drills holes in the lawns in search of insects on which it feeds. It is very often seen sitting in a certain place making its characteristic 'Hu Hoo' note for a long period. For each note it bows its head.

Koel (Fig. 11.11 F)

The male and female koels are different in colour. The male koel resembles a crow. It has a slimmer body and a longer tail than a crow. The female koel is brown with white specks. Koels produce a low insistent series of shrieks "Ku-o-o-Ku-oo-o". Each shriek is higher than the previous one.

They lay eggs in the nests of crows. The crow brings up their chicks. At the breeding time, the male koel approaches a crow's nest. The crows chase the male koel. Meanwhile the female koel lays her eggs in the crow's nest.

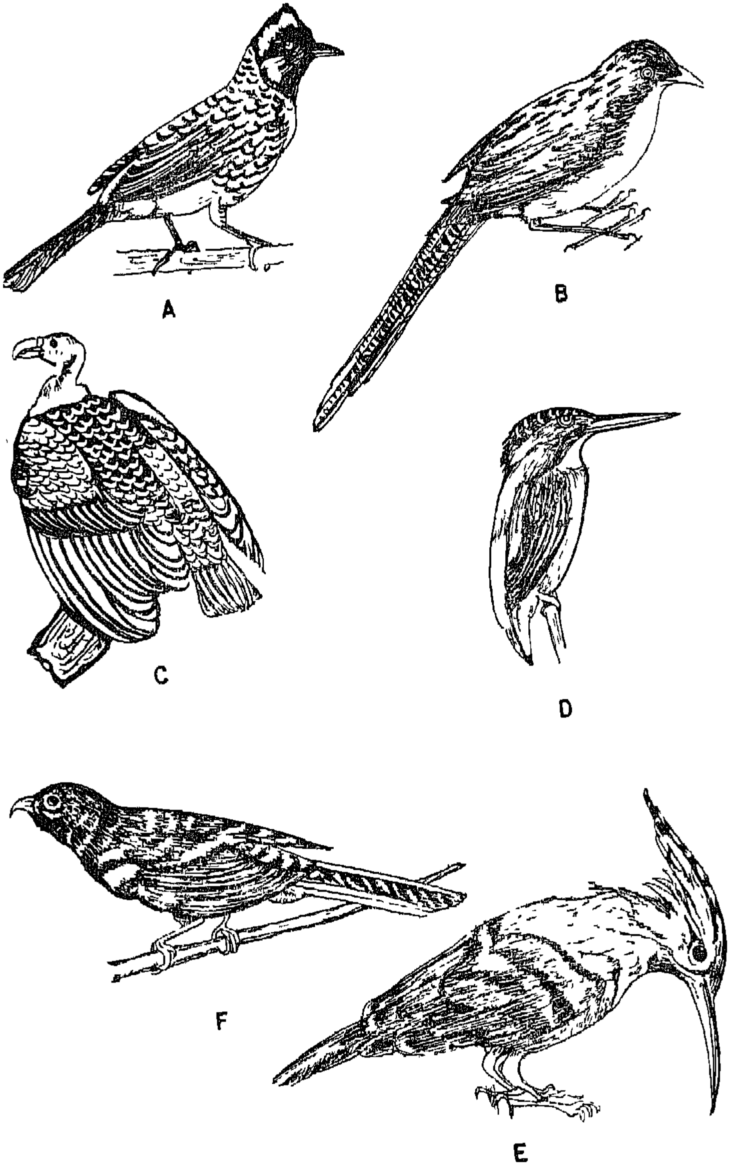


Fig. 11.11. Some interesting birds :
A. Red vented bulbul ; B. Babbler ; C Vulture ;
D. King fisher , E. Hoopoe ; F. Koel.

Different regions of the world have different climatic conditions. Animals living in a certain region are adapted to their surroundings. Thus animals living in certain cold regions are not ordinarily found in other regions of the world. This is true of different kinds of animals including birds. Thus the bird fauna might differ in different regions of the world. But birds have one advantage which many other animals do not have. Birds can fly long distances in a comparatively short time. If the local climatic conditions become unfavourable for the birds they can escape by flying to distant places. But not all birds possess this power for flight. There are many birds that spend their whole life in their native land.

Some birds that are found commonly in certain places, suddenly disappear. For some time, they are not seen in these places. But after a few nonths, they appear again. This appearance and disappearance of birds remained a puzzle for a long time. Some people in the past thought that some kinds of birds changed to other kinds of birds during certain seasons. Some others thought that birds buried themselves in the mud during the winter, just as the frogs do. All these appear to be funny ideas now. Now people know that birds from one region migrate to other regions. After some time they come back to the same region. The time of appearance and disappearance of birds in a region is the same every year. This periodical movement of animal from one region to another and back to the original region is known as *migration*.

Why do birds migrate ? We know that many birds leave their breeding place during winter. They go to places where the climate is warmer. It is, because, during winter the vegetation and food become scarce for the birds. The days are short during winter and this shortage in the day time gives them less time to search for food. Winter is always very cold. To escape from all these factors the birds migrate to places that are favourable to them. The migration is mostly in opposite directions, north to south and back.

The range of distance between the breeding and the feeding places of a bird varies. In many cases it exceeds several thousands of kilometres. A bird called Artic tern travels from the Artic region to the south covering a distance of about 17,500 kilometres. Some birds of North India and the base of the Himalayas visit places in South India. Similarly many birds are known to migrate from various foreign countries like U.S S.R. to India.

How do we know that birds migrate? Some birds, known to disappear from a place are caught alive and aluminum rings are attached to their legs and then they are released. This is called *ringing*. The aluminium ring carries the particulars of the date, place of release and the address of the person who ringed the bird or his organization. In different parts of the world there are bird watchers. They constantly look for birds appearing in their country. The people who catch the birds bearing the ring report the date and place of capture to the persons concerned. From all these the routes, distance covered, probable speed of migration and other factors are found out.

What makes the birds undertake migrations is still not fully understood.

ROLES OF BIRDS IN KEEPING DOWN PESTS

Many birds feed on insects. Birds that eat insects help to protect forest trees from destruction by insects. Birds also eat insects that harm our crops. By eating insects the birds help us in protecting many of our cultivated and useful plants and minimize the destruction of their products.

Hawks and owls eat mice, rats and similar harmful animals. It there were no such birds a great deal of harm would occur to our crops.

Weeds are unwanted plants. If these are allowed to grow along with our useful plants, they compete with the latter for food and reduce their growth and yield. Some birds feed on the seeds of these weeds and keep down their numbers. In the absence of such birds farmers will have to fight harder to keep down weeds.

BREEDING OF USEFUL BIRDS : COMPARISON OF THE WILD AND DOMESTICATED VARIETIES OF FOWL AND PIGEONS

Wild hens are found in the jungles. They are small in size weighing 600 to 800 gm. They lay 9-12 eggs in a year. The domesticated hens are large in size weighing 2-5 kg. and lay a maximum of 300 to 320 eggs. All the domesticated hens were obtained in the past by breeding the jungle fowls. By continuously selecting and breeding fowls that showed capacity for more egg production and more meat, man succeeded in getting different kinds of modern fowls. White Leghorn and Black Minorca lay large numbers of eggs. Rhode Island Red lay less number of eggs than the White Leghorn but its body has plenty of flesh. Man is trying further to improve the varieties of fowls for getting the maximum utility from them.

The domesticated ducks were similarly obtained by breeding the wild ducks. The wild ducks are migratory in habit, lay only a few eggs and their growth-rate is slow. The domesticated ducks have lost their migratory habit, lay more eggs and their growth rate is good.

All the different kinds of domestic pigeons were derived originally by breeding the wild pigeons. Domesticated pigeons are useful to man in several ways. They are eaten, kept as birds of beauty, used as messenger birds and reared for pigeon race. Each type of these pigeons should have different body features. Man succeeded in getting the desired characters by carefully selecting and breeding the pigeons.

SUMMARY

Birds are warm-blooded vertebrate animals adapted for flying. The adaptation for flying is seen in almost all parts of their body. The feather-covered body, modification of the forelimbs into wings, hollow light bones, lungs with air sacs are some of the prominent features adapted for flying. All birds reproduce by eggs. Certain range of higher temperature is needed for the development of eggs.

The birds are adapted for different modes of life. The diversity in the life of birds is reflected in the structure of their beaks and limbs. Different birds make use of different places and different kinds of materials for making nests.

Birds resemble reptiles in some features. Birds are believed to have originated from reptiles. An ancient bird now discovered as a fossil shows many features that combine the characteristics of reptiles and birds. This extinct bird is *Archaeopteryx* which had feathers, beak with teeth and a long tail.

Though most birds fly, some birds like ostriches and penguins cannot fly. Many of the adaptations seen in flying birds are not found in these fightless birds.

Some birds spend a part of every year in their breeding places and other part in their feeding places. The periodic movement to these two places is known as migration. Migration is studied by ringing and recovering the birds. Birds help us in keeping down insects and other agricultural pests. Domesticated birds were obtained by breeding and selecting wild birds.

QUESTIONS

1. **What do you understand by the term warm-blooded animal ?**

2. Birds are well adapted for flying. Name some of these adaptations.

3. Write a short account of any three kinds of nests of birds observed by you.

4. In what features does a bird resemble a reptile and in what features does it differ from it ?

5. What is Archaeopteryx ? On what reason do y state that birds have originated from reptiles ?
6. What is meant by migration of birds ? Why do bir migrate ?
7. In what way birds are useful to man ?

Tasks

1. Observe the habits of common birds of your localit
2. Collect and exhibit different nests of birds.
3. Draw and paint the pictures of the beaks and feet birds of different modes of living.
4. Study the different stages in the development of h eggs.